NOVEMBER 10, 1960

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY

Converting Curves to Straight Lines

Mr. Stevens Rice
University Microfilms
313 North First Street
Ann Arbor, Michigan

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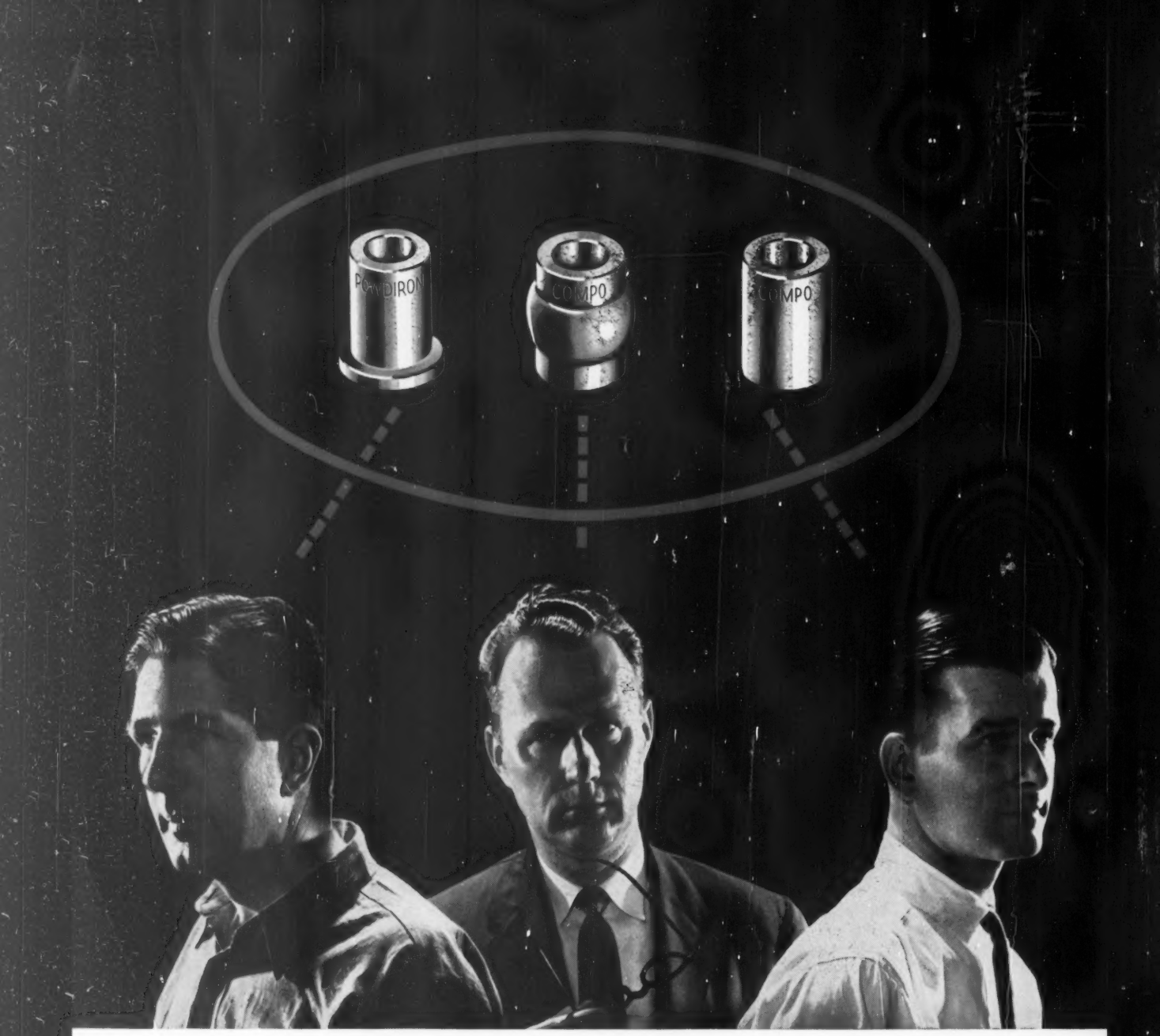

Specialization in bearings enables us to apply to your bearing problems an unmatched engineering talent and experience in powder metallurgy. You benefit, too, from outstanding manufacturing facilities, including the world's largest inventory of dies. Whatever your need, when it's bearings, see the bearing specialists ... see Bound Brook.

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Pioneer in Powder Metallurgy Bearings and Parts.
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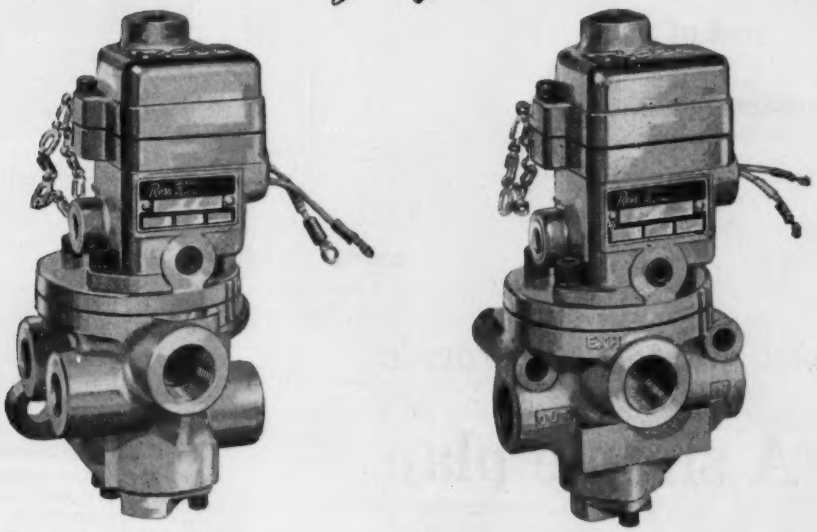

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A complete new series of inline valves, sizes one-quarter inch through one and one-half inch, straightway, 3-way and 4-way. These valves, size for size, will operate faster, longer, and provide greater capacity than any other valves we have been able to find.

When the price, quality and performance and Ross reputation are taken together in evaluating this series, it represents probably the best valve value available today. Before you specify any valve after today, you owe it to yourself to look into the "headline" series. Write for full information.

Ross OPERATING VALVE COMPANY

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Circle 404 on Page 19

lower your cost of possession

2 Nickel Alloy Steels provide

A simple plan to save money by Steel Standardization

How many types of steel do you normally use?

Chances are you should examine your needs for alloy steel to see how many can be satisfied with just two types, 4340 through-hardening and 4620 carburizing.

You are likely to find that most of your engineering requirements can be met with confidence when you *standardize* on these two general-purpose steels.

You simplify inventory and materials-handling. You save money in purchasing and production, too.

• 4340 stands alone among medium-carbon steels in its ability to provide maximum strength, ductility, toughness and resistance to fatigue in parts of medium to heavy section.

• 4620 is a carburizing type that has consistently proved itself the ideal steel for a wide variety of carburized parts. 4620 is easy to carburize and has a minimum tendency toward distortion in heat treatment.

Available From Steel Service Centers Both 4340 and 4620 are stocked by Steel Service Centers from coast to coast, ready for off-the-shelf delivery in a variety of sizes.

When you have carried your standardization plan as far as you can and you still have specialized needs to fill, the right nickel steels are available to give you extra performance or even lower costs.

For a buyer's guide to Steel Service Centers that stock 4340 and 4620, and other nickel-containing grades, simply write Inco.

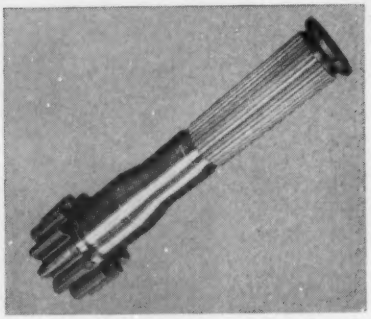
INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

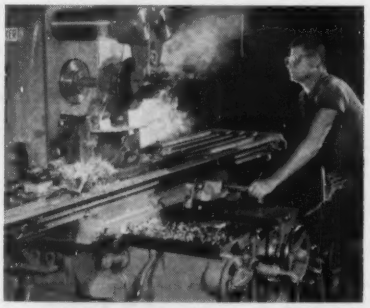
STEEL SERVICE CENTER INSTITUTE

Holding the Shippingport nuclear reactor's top head to its shell section is a job performed by 42 studs of AISI 4340. This through-hardening nickel steel provides essential strength and toughness.

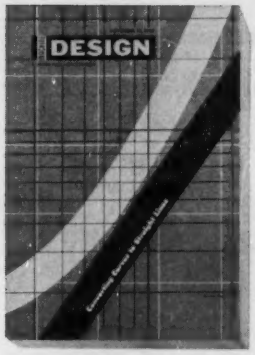
Power-packed tractor features unique drive mechanism composed of regular gear transmission, clutch and torque converter with lock-up, utilizes nickel alloy steels in more than 25 components.



Swing shaft for giant power shovel made from 4340 nickel alloy steel for strength and toughness to take shock-loading in stride. This 9″-diameter, 36″-long shaft of 4340 nickel alloy steel transmits tremendous torque to a giant ring gear.



Sustained accuracy is assured in this heavy-duty milling machine by spindle and gear components of AISI 4340 and 4620 nickel alloy steels. They provide needed strength and wear resistance.



Front Cover: Changing a curve on linear scales to a straight line on log scales can be a little more complicated than artist George Farnsworth makes it look in his cover design. However, W. J. Worley irons out such situations in his article which starts on Page 173.

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Whatever your flexible metal tubing problem, Anaconda's broad design and manufacturing capability can make your job easier

The big corrugated stainless steel tubing assemblies shown above were designed and manufactured by Anaconda Metal Hose for water lines in the missile program. Construction of these 12" I.D. lines is corrugated stainless steel flexible tubing, reinforced with stainless steel wire braiding; end fittings are floating flanges. This type of tubing can also be produced in other metals as Bronze, Steel, in standard ID's through 16" and standard lengths of 20 feet.

Small flexible tubing for small tough jobs, too. At the other end of the scale are tiny ⅛" Vibration Eliminators. And in between, the variety of flexible hose assemblies — in size, material, and design — is almost infinite.

Sales Engineering Consulting Services that follow through from original design to finished product. Simply let us know your needs, with conditions, dimensions, and such sketches and drawings as might be necessary to give us an understanding of your problems. We will work out design problems with your engineers and draftsmen. We will manufacture the flexible connectors. And we will make specialists available for immediate service calls on equipment or field installations. These services are available through our representatives in leading cities—see listing "Hose-Metal" in the Yellow Pages. Or write: Anaconda Metal Hose, Box 791, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

ANACONDA®
Metal Hose

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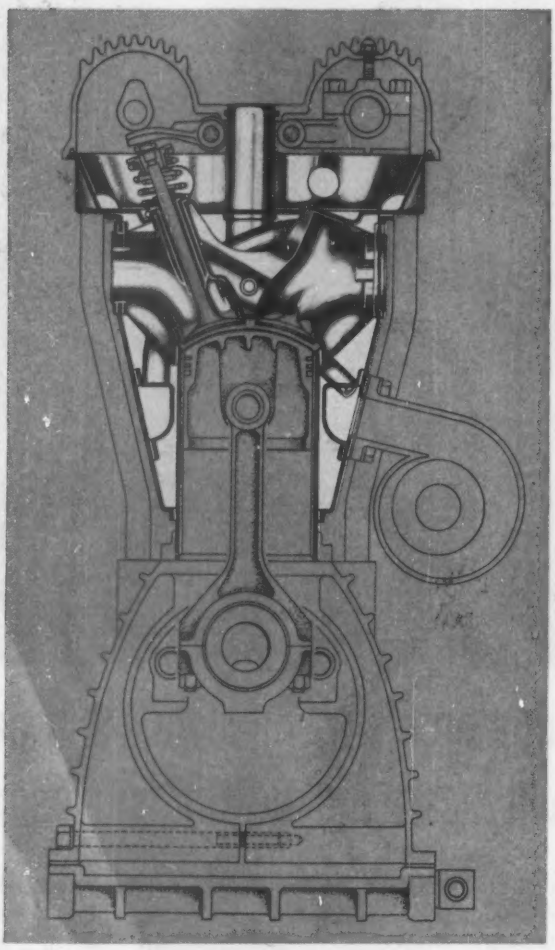
The Sheet-Metal Engine —175 hp from 175 lb



Brazed assembly of stainless steel stampings—cylinders and cylinder heads, water jacket, intake and exhaust ports, upper block pan, and spark plug-tubes—forms the lightweight block on the Tyce-Taylor engine. Stampings are first tack-welded to retain alignment, then pressed as a unit in a cast-steel hold-down flange. Entire block is then brazed in a hydrogen-filled gas or electric oven at 2100 F. Each part is so designed that heating and cooling produce virtually no measurable distortion, despite different coefficients of expansion.

DETROIT—Several hundred automobile designers attending the recent convention of American Society of Body Engineers in Detroit are probably still talking about a remarkable new engine displayed during the session. They were properly impressed on two counts: First, the engine had a block made of sheet-metal stampings. Second, it had a power-to-weight ratio of 1 hp per lb. The model on display weighed 175 lb, developed 175 hp.

Nearing full-scale production at Tyce Engineering Corp., Chula Vista, Calif., the new water-cooled four was designed by Lloyd Taylor, well known in automotive circles for his work on the post-war Crosley "Cobra" engine which was built of copper-brazed steel. Tyce, manufacturer of missile and aircraft components, contributed plenty of space-age experience in the fabrication of stainless steel.

Quick-Change Displacement

Available in four displacement sizes (91, 105, 120, and 135 cu in.), the T/T engine can be converted from one size to another simply by replacing the crankshaft to change the stroke (which ranges from 2.375 to 3.5 in.). All sizes have the same 3.50-in. bore, develop maximum power at 6500 rpm, and respond to performance improvement via turbo charging. And all have an unusually high compression ratio—12 to 1 is standard; 14 to 1, optional.

Because the stainless-steel sheet used to form the various block components can be held to a uniform wall thickness, the engine cools evenly without hot spots. The thin-gage metal (0.090 in.) used for the combustion chamber and ports also dissipates heat several times faster than a cast block eliminating the tendency to pre-ignition "ping." A 0.063-in. liner of AISI 4130 steel is brazed in each cylinder to provide exceptionally low wear and long engine life.

Several standard components from Detroit cars were adopted for the engine, including Thunderbird intake and Pontiac exhaust valves, Chevrolet-Six valve guides, and Ford-Six connecting rods. Transmission options are also standard Detroit products: Corvette 4-speed

...Fluid Power news

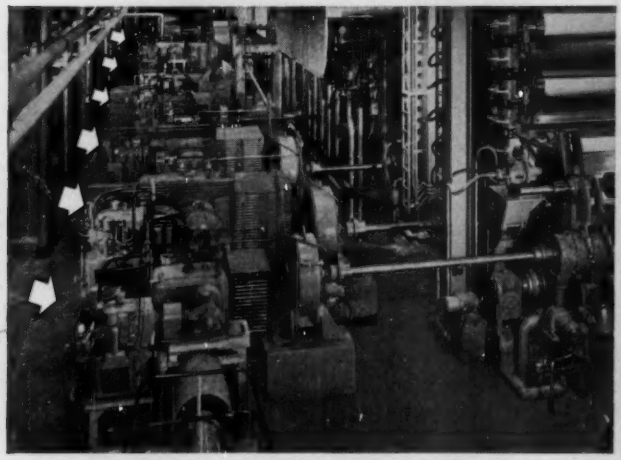
REPORT NO. 12,106 NEW PAPER MACHINE SECTIONS OILGEAR CONTROLLED

From Oilgear Application-Engineering Files

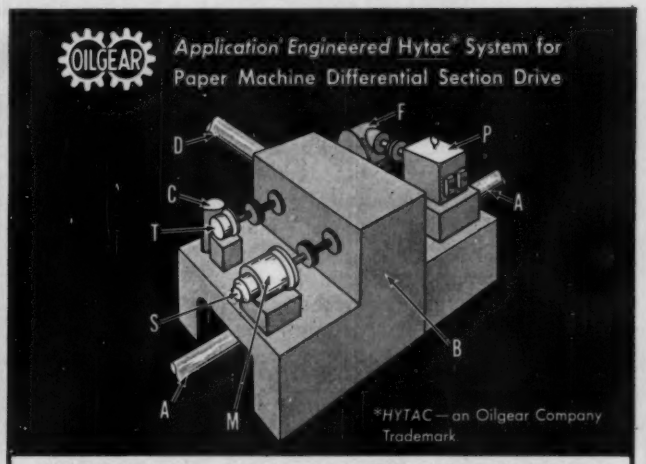
HOW *HYTAC** SYSTEMS PRECISELY CONTROL SECTION SPEEDS OF VERSATILE NEW PAPER MACHINE

BUILDER: *Paper Machine and Differential Drives — Beloit Iron Works, Beloit, Wis.*

DATA: Systems to individually vary and precisely control speed and draw on six sections of a new, versatile, 192-in., 90-ton capacity, Beloit fourdrinier paper machine designed to produce a variety of finished stock ranging from 33-lb toweling up to 190-lb food board. For 200- to 2000-fpm production operation—a range not previously considered practical—main lineshaft speed to be adjustable over this 10:1 range. Beloit mechanical differentials to be used at each section. **REQUIREMENTS:** 1. Precise speed and draw control for each section—infinitely variable up to 10% under main lineshaft rpm—from simple, remote, push-button control panels. 2. Maintain each selected section speed within ±0.25% max. variation over a 50% load change at max. lineshaft speed. 3. Must be compact; frugal on electrical power input; insure trouble-free, continuous, heavy-duty, full-production paper machine drive service, and still provide maximum adaptability for short runs. 4. Be impervious to high humidity and high-pressure wash-downs. 5. One reputable source and responsibilty for these speed and draw control systems preferred.



Drive side of this versatile, new paper machine. "... to give perfect draw and speed control over an unprecedented wide range"... six Beloit differential drives incorporate *HYTAC* Systems*—indicated by arrows. This machine consumes approx. 39,000 tons of pulp per year in the production of grades ranging from 33-lb bleached and unbleached toweling to 190-lb coated or calendered food board.



HOW DRIVE WORKS: One of the six combined *HYTAC** and Beloit differential drives is shown schematically above. The turbine-drive lineshaft (A) drives all Beloit Mechanical Differentials (B). Controlled *Fluid Power* is delivered by Oilgear Variable Displacement Pump (P) driven by Differential (B) through Speed Increaser (F). *Fluid Power* from Pump (P) drives an Oilgear Constant Displacement Motor (M) to decrease speed of Section Drive Shaft (D). Oilgear Variable Displacement Master Tachometer (T) driven by Differential (B), and controlled remotely by electric Pilot Motor (C) delivers controlled low-pressure fluid to Oilgear Constant Displacement Slave Tachometer (S)—directly connected to Motor (M). Fluid in branch line from tachometer system operates hydraulic control on Pump (P). Operator can infinitely decrease rpm of Section Drive Shaft (D) up to 12% under lineshaft rpm—over entire 10:1 lineshaft range—by local or remote pushbutton stations connected to Pilot Motor (C) on Master Tachometer (T). Changing volume and/or direction of flow in tachometer system accurately changes volume and/or direction of fluid flow from Pump (P) to Motor (M). When main lineshaft rpm is increased or decreased, *HYTAC** System automatically, precisely synchronizes Driveshaft (D) rpm. All factors such as changes in load or temperature are automatically compensated for by these *HYTAC** Systems to maintain exact, set degree of section synchronization at all times.

SOLUTION: Application-Engineered *HYTAC** controlled differential drives provide precise, individual speed control on each of the following six sections of this new paper machine—20-hp Oilgear *Any-Speed* Drives on size press, 4th dryer, winder reel; 35-hp drives on 3rd dryer, 1st calender, 2nd calender. A typical *HYTAC** and Beloit differential section drive and its components are shown schematically, right.

These systems maintain any selected, individual section speed with less than ±0.25% variation regardless of load change over the entire 10:1 range of lineshaft speed . . . plus enabling operators to infinitely vary each section's drive rpm independently up to 12% under main lineshaft rpm.

A special slack take-up feature facilitates rapid change-over on short runs. This "Oilgear-Plus" feature operates from a momentary, over-ride, control panel pushbutton to rapidly take any one or all sections from threading speed to the desired production speed. Other "Oilgear-Plus" features are: 1. Cushioned, controlled starting, accelerations, deceleration, braking. 2. Positive, automatic overload protection. 3. Constant pressure and flood lubrication with continuous power fluid filtration. 4. A heavy-duty, long-lived, trouble-free, efficient, *sealed system*—impervious to high humidity and washdowns. 5. Complete freedom from maintenance-provoking belts, chains, or relays.

Circle 407 on Page 19

These Oilgear-Beloit Systems enable operators to equalize draw between sections, to increase draw or slack at specific sections, and to prevent overload on one or more sections.

They have met or exceeded all originally specified requirements. In this age of special, single-purpose machines, this new paper machine is unique in its versatility—being fully capable of long runs, it is, however, particularly adapted and used for short runs — competitively producing the many different types, weights, and finishes of stock. • . . . In addition, an 800-ton *Washington Iron Works* pulp baling press, and a *MURCO Wood Splitter* in this mill are also equipped with *Oilgear Application-Engineered Fluid Power Systems.*

For similar practical solutions to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

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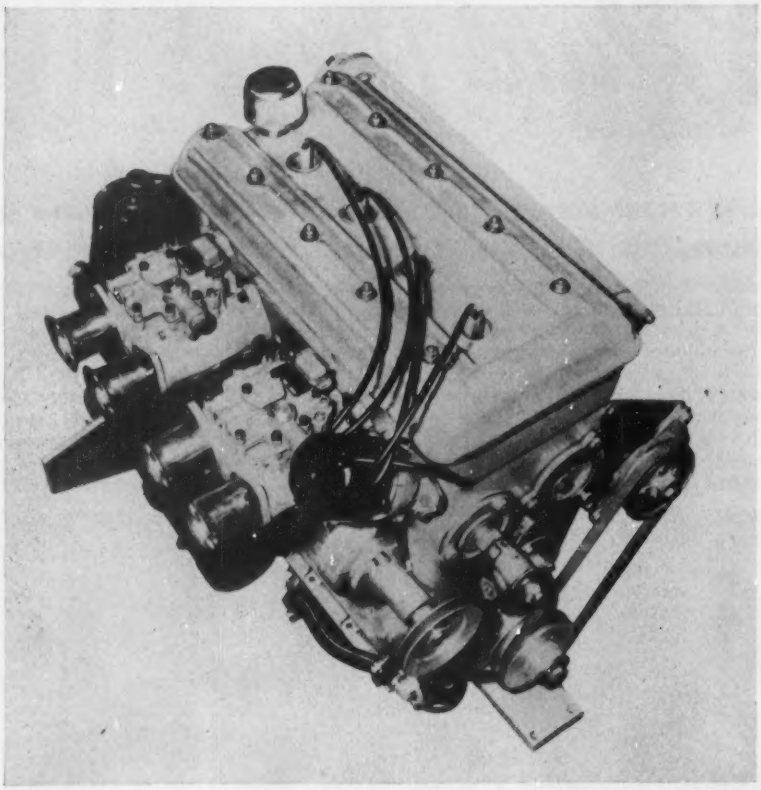
and Falcon 3-speed units are among those recommended. Carburetion is equally flexible. The four intake ports are located on 4-in. centers and will accept a variety of carburetor combinations, including four single-venturi side-draft models, two duals, fuel injection, or a single down-draft carburetor on a long manifold.

Weight of the engine in its four different displacements is about the same—175 lb without starter or generator. The 105 cu in. size is tailored exclusively for midget racing where it will compete with the highly developed Meyer-Drake (Offenhauser) engine. The 91 cu in. size provides increased performance possibilities for inboard racing hulls.

To prove its potential under the toughest conditions, the T/T engine has been installed in several boats and is scheduled for early test in sports-car and racing-car competition. Special adaptor units permit the engine to be "swapped" into a variety of sports cars including MG, Triumph, and Austin Healy. Its high-performance capability is also expected to be welcomed by the military for airborne and ground-support equipment.



135 cu in. . . . . 175 hp
120 cu in. . . . . 150 hp
105 cu in. . . . . 125 hp
91 cu in. . . . . 115 hp

Available in four different displacements and power ratings, the Tyce-Taylor engine has these dimensions: Length, 21.6 in.; height, 24.5 in.; width, 11.5 in.

Air Force Seeks 60-G Pilot Protection

DALLAS — A restraint system to protect pilots against a landing-impact force as high as 60 g is subject of an Air Force contract with Chance Vought Aircraft, Inc. Designed specifically to protect astronauts in event of a "hard" landing, the restrainer will also guard against the accelerations of rocket boost, extreme decelerations of reentry, and other shock forces.

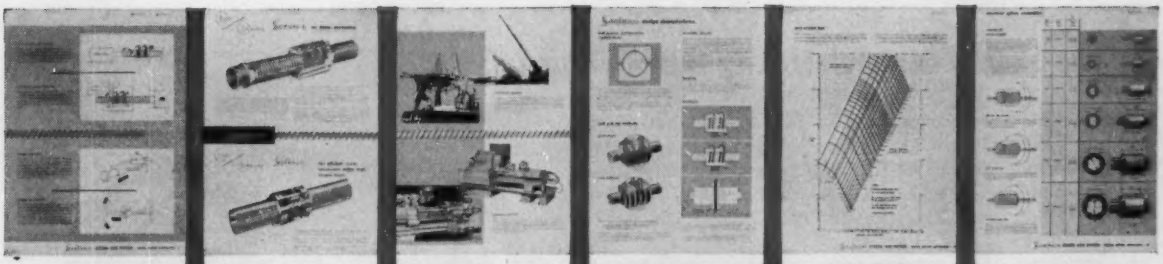
The 60-g force is roughly equivalent to that imposed on a motorist who slams his car into a brick wall at 60 mph. Since the restraint system may be needed with a minimum of warning time, CV engineers say that it will be designed to sense dangerous stresses prior to their occurrence and go into operation automatically to position and restrain the pilot. The engineers also point out that in a hard landing the astronaut could encounter forward, backward, or side forces, depending on the type of vehicle and its attitude on impact. The restraint system will be designed to protect against 60-g forces in these directions, and against 30-g forces upward and 20-g forces downward.

Although 60 g in the forward position exceeds tolerance levels demonstrated in tests with man to date, CV engineers believe man can safely survive the force if properly protected. They point out that AF Colonel John P. Stapp withstood forward decelerative forces as high as 45 g in high-speed rocket-sled runs several years ago.

In searching for pertinent information on the subject, CV engineers aren't confining their efforts to formalized data. Records of unusual falls and crashes are also being studied to determine conditions which have permitted survival at great impact rates.

One case uncovered by the engineers concerns a workman who fell 145 ft from a chimney scaffold. He landed on his left side with his face in rubble, but received non-critical injuries from which he rapidly recovered. Engineers estimate that the workman withstood an average deceleration on the order of 162 g, and that the peak force was probably closer to 300 times his body weight. Since the workman weighed 155 lb, the force acting on his body during deceleration was in excess of 25,000 lb. At Chance Vought's 60-g goal, forces acting on a 200-lb man would be 12,000 lb.

In the workman's case, soil and rubble acted as a restraint device. Distribution of stresses over a wide body area and a "give" of about 8 inches in the ground were factors contributing to his escape with minor injuries. Scientists are seeking similar weight distribution and give in the restraint system. But where the workman's chances were perhaps one in a million, their system must work every time.



BASIC PRINCIPLES
Illustrated diagrams of the operating principles of the ball bearing screw and spline clearly demonstrate the simplicity and dependability of their function.

TYPES
Mechanics of ball bearing screws and splines show how they are designed for linear positioning and efficient linear movement under high torque.

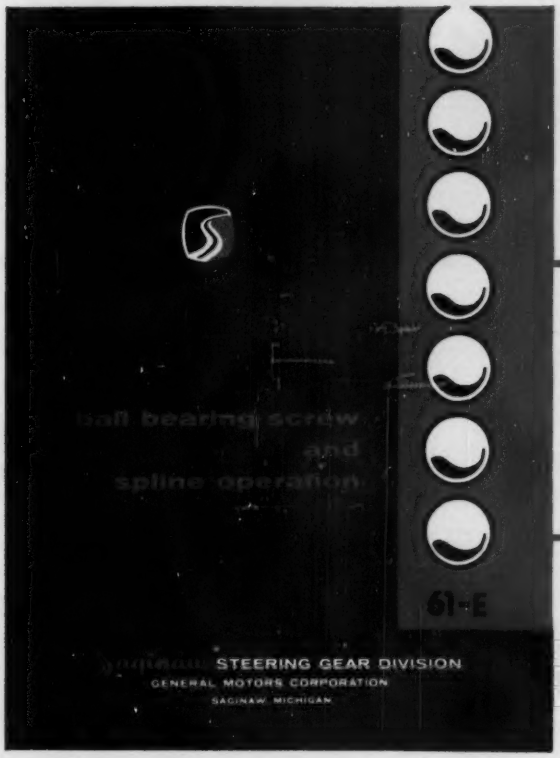
APPLICATIONS
Actual applications of the Saginaw Ball Bearing Screw in industry and defense are shown. These examples illustrate Saginaw Screws' versatility.

DESIGN DATA
Design characteristics list details on ball groove configuration, guide finger and yoke deflector ball pick-up methods, ball nut loading, backlash, etc.

SAMPLE PROBLEMS
Preliminary design factors enable you to determine ball bearing screw or spline size in relation to application life, hardness and load factors.

ASSEMBLIES
Suggested means of attachment help you choose the one that's best for moderate torque, heavier torque transmission, and other load situations.

SEND FOR NEW '61 ENGINEERING DATA BOOK



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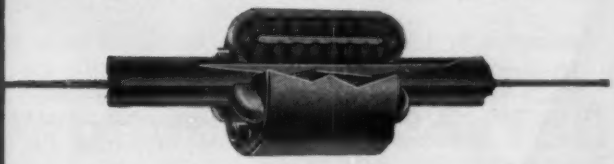
SAGINAW b/b SCREWS offer over 90% efficiency, 4/5 less torque, in actuating, positioning functions. Help lower operating costs, reduce maintenance, simplify design, often cut installation costs. Adapt to electrical, hydraulic, mechanical, pneumatic operations. Unlimited sizes.



SAGINAW b/b SPLINES greatly increase operating efficiency by providing easy linear movement even when functioning under high torque or bending loads. Permit significant savings in weight, power and space. Reduce wear—increase safety, lifespan and dependability.

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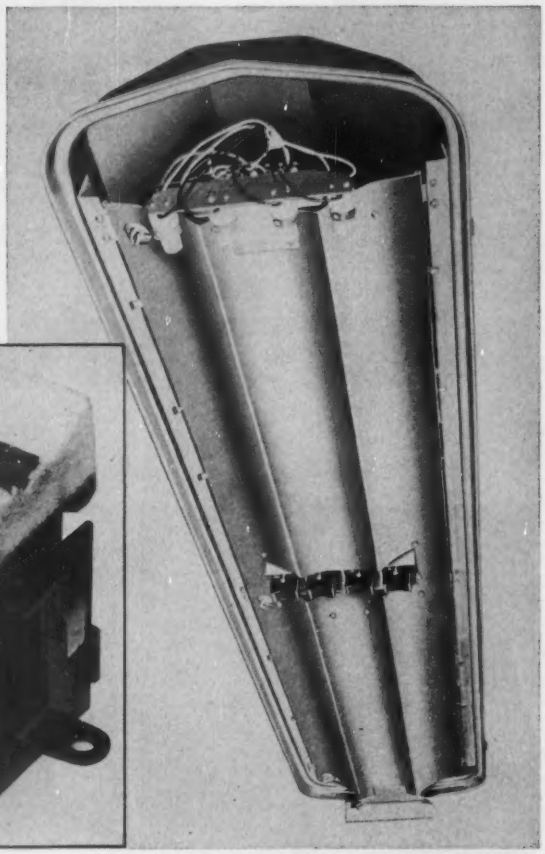
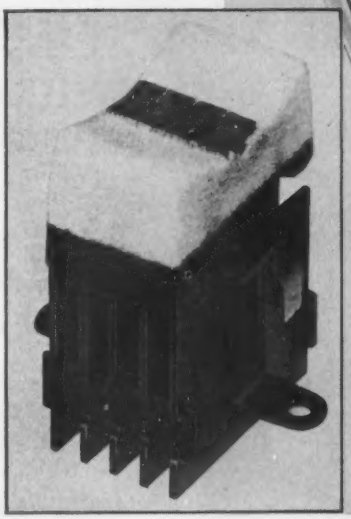
Off-the-Shelf Thermoelectricity Boosts Lamp Output

Thermoelectric spot coolers let four fluorescent tubes do the work of seven. By chilling each tube to maintain mercury-vapor pressure at an optimum value, the coolers increase lamp output by 72 per cent. Designed and built by Minnesota Mining and Mfg. Co., St. Paul, Minn., the devices are automatically regulated (by a thermostat) for temperature variations; light remains at an almost constant level as ambient temperature varies from below zero to 77 F. The spot coolers, one of the few existing applications of thermoelectricity, are powered by a low-voltage dc supply housed in the lamp fixture on models manufactured by Line Material Industries, Milwaukee.





Off-the-shelf spot coolers are available in two basic types: Model 10-L, equipped with flat cold shoes for application to flat surfaces; Model 10-J, designed with concave cold shoes. Modules of both types consist of four thermoelectric couples, each couple containing a copper shoe, a P and N element, and a copper cooling fin. For strength and moisture protection, couples and shoe contacts are imbedded in foam epoxy. Able to operate at temperatures up to 250 F, spot coolers can handle high heat loadings and, if necessary, additional couples can be added to increase the capacity of a single module. Liquid cooling of the fins is possible for applications where more efficient heat dissipation is necessary. Other models of spot coolers are available on special order from Minnesota Mining and Mfg.

Instrument Measures "Zero" Pressure

Ionization by Ultraviolet Eliminates Gas Contamination

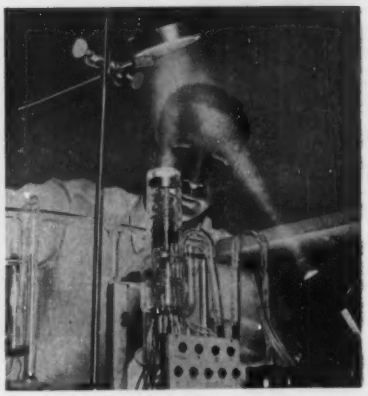
PITTSBURGH — A new laboratory tool developed by Westinghouse Electric Corp. measures pressures as low as 10^{-10} mm of mercury. Because the device, called a photomultiplier ion gage, doesn't need a hot filament, it could revolutionize low-pressure techniques.

All low-pressure instruments add electrical charges to the gas being measured, then count the number of ions formed—the more ions, the higher the pressure. Conventionally, the charges come from electrons that are boiled off the surface of a hot tungsten filament located in the near vacuum. Such hot-wire instruments are limited in accuracy since the gases react with the hot filament, breaking down and forming new substances. The act of measuring gas pressure contaminates the gas.

The photomultiplier ion gage overcomes contamination effects by replacing the usual hot filament with a beam of ultraviolet light. Ions are formed indirectly; the light, beamed on a metal plate, knocks electrons out of the metal, and the electrons then ionize gas molecules.

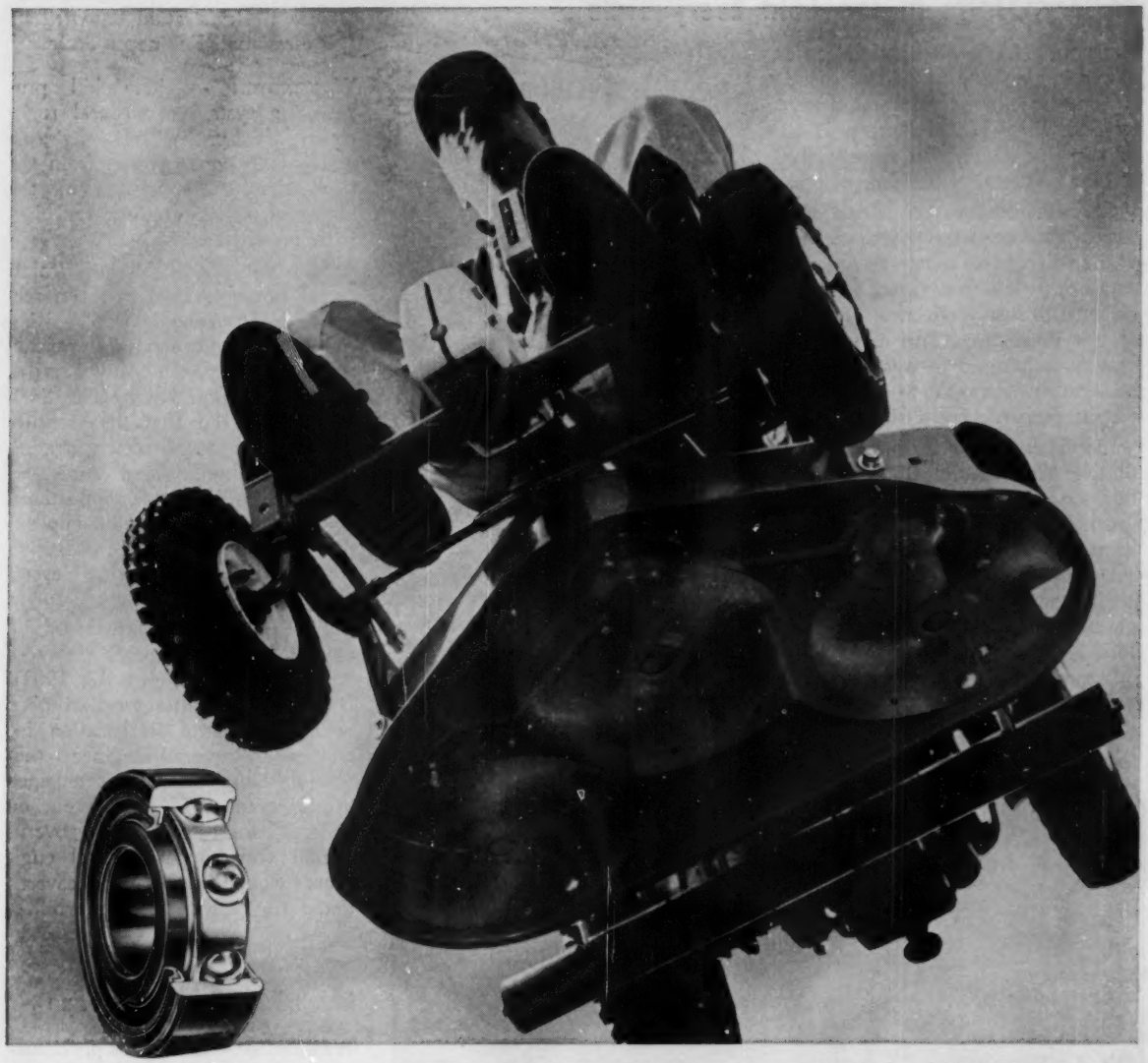
According to Westinghouse, the new tool will be useful in a variety of ultrahigh-vacuum experiments. It's ideally suited to studies of interactions between hot filaments and gases, such as those encountered in electronic tubes and thermionic converters.

In addition, the device has been put to work measuring pressures encountered in space at distances between 50 and 650 miles above the earth's surface.



Ultraviolet light releases electrons from a metal target in the new Westinghouse photomultiplier ion gage. The device, developed to measure pressures in the 10^{-3} to 10^{-10} mm of mercury range, notes the rate at which electrons ionize the gases present—a direct measurement of pressure. Developed as part of the Atomic Energy Commission's Project Sherwood, the gage will be a big help toward achieving controlled nuclear fusion.

NEW DEPARTURE CASE HISTORY

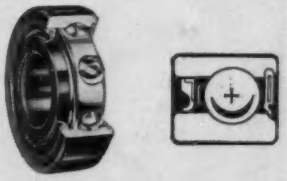


HOW N/D BALL BEARINGS REDUCE MOWER MAINTENANCE AND PRODUCTION COSTS!

PROBLEM: Manufacturer of well-known power lawn mower wanted to make unit more maintenance-free.

SOLUTION: Complete re-evaluation of all rotating parts including a study of rotary blade bearings by N/D Sales Engineer. His recommendation: Replace six existing non-integrally sealed bearings with lubricated-for-life New Departure ball bearings. These factory greased bearings are equipped with integral Sentri-Seals* and Land-Riding Seals. Results: Greater consumer sales appeal by doing away with the need for relubrication maintenance. In addition, N/D's compact ball bearings reduce production cost by eliminating separate bearing seals and six unnecessary grease fittings.

If you're designing new products involving bearings, invite a N/D Sales Engineer to your next design discussion. His knowledge of bearing engineering may result in a savings and valuable new product sales features. Contact him at your local N/D Sales Engineering Office, or call or write New Departure, Division of General Motors Corporation, Bristol, Connecticut. *New Departure Registered Trade Name.



Integrally sealed N/D ball bearings eliminate need for relubrication, grease fittings and separate seals. These heavy-duty N/D bearings with Sentri-Seals* and Land-Riding Seals, shut out moist or dry contaminants.

NEW DEPARTURE

BALL BEARINGS · PROVED RELIABILITY YOU CAN BUILD AROUND

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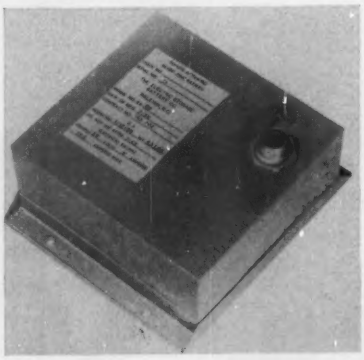
Battery Starts in the Cold Every Time

RALEIGH, N. C.—Reliable electric power in the subzero cold of space is supplied almost instantaneously by a new self-heated battery. It is the first of its type to successfully employ a chemical heating device.

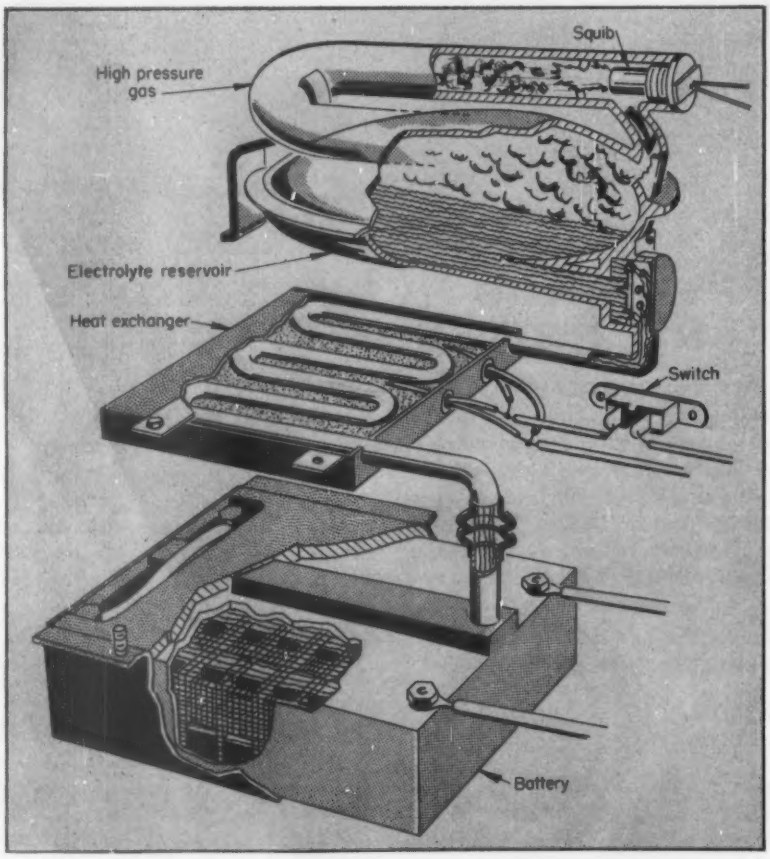
Chemical combustion within the battery case heats the potassium hydroxide electrolyte to operating temperature in less than 6 sec, without recourse to heavy electrical apparatus for preheating. This allows the battery to be used in weapons that hitherto were unable to afford the weight penalty of electrical power.

Manufactured by Electric Storage Battery Co., Missile Battery Div., the power source can deliver 12½ watthours per pound, including heater. In two versions of the silver-zinc battery (28-v units already in production missiles), activation takes place over a range of −65 F to 165 F. Both models operate for 15 minutes, delivering 20 amp.

A more compact model, rated at 28 v, 10 amp-hr, activates in less than 3 sec at −40 F to 165 F.



Automatically activated battery heats almost instantly after it receives an input signal in the form of a low-power pulse of electricity. The signal explodes a squib that releases high-pressure gas into the upper electrolyte reservoir. This expels the electrolyte through a copper heat exchanger. Simultaneously, electrical matches ignite a chemical powder surrounding the heat exchanger. As electrolyte flows through the exchanger into the dry-charged battery elements, it is heated to operating temperature. If the battery is warm, a thermostat prevents ignition.



Foley Bill Dies in Committee

Federal Registration Opposed by Professional Engineers Society

WASHINGTON — The bill proposing a system of Federal registration for professional engineers received no consideration from the Civil Service Committee of the House of Representatives, and died with adjournment.

The National Society of Professional Engineers had gone on record as being opposed to the bill because it would seriously weaken and curtail the effectiveness of state registration laws. The Society pointed out that the measure would have permitted registration without examination of some persons of questionable qualifications, was vague in its ultimate application, and generalized the definition of "practice of engineering" excessively.

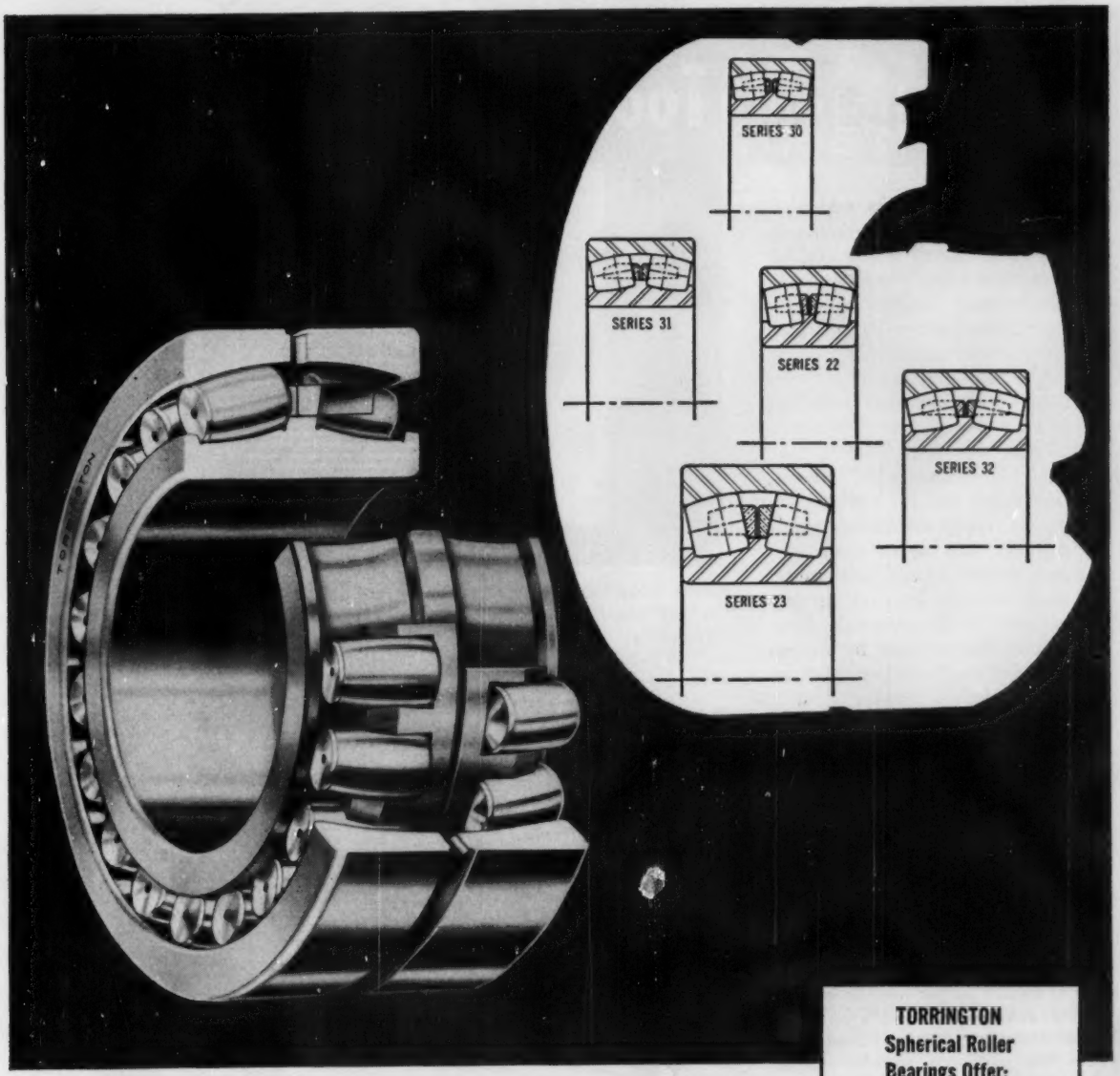
The measure was introduced by request by Rep. John R. Foley of Maryland (MD August 18, 1960). It provided for the creation of a Federal Board of Registration for Federal Professional Engineers that would license all persons engaged in the practice of engineering on Federal Projects. Both governmental and nongovermental engineers would have been covered under the provisions of the bill.

Blueprints Without Red Tape

WASHINGTON—Blueprints previously obtained from the Atomic Energy Commission will be supplied through an outside contractor in the future. This procedure is one early step in the Commission's program to discontinue services that can be reasonably carried out by private firms.

Cooper-Trent Blueprint and Microfilm Corp., Arlington, Va., will fill all requests for full-size blueline prints of engineering materials (drawings, specifications, photographs, and bills of materials). Previously this service was performed by the Office of Technical Information at Oak Ridge, Tenn.

The prints will be sold at an established price of 17 cents per sq ft, with substantial discounts for large orders. The contractor hopes to provide a 24 hr service.



There's a Torrington Spherical Roller Bearing for your application

Bearings matched *exactly* to the job pay off in better performance, longer life, greater reliability. That's why it pays to specify carefully. And that's why it pays to choose Torrington Spherical Roller Bearings.

Whatever your space limitations or capacity requirements, the five series of Torrington Spherical Roller Bearings provide the right bearing for virtually every industrial application. You can design for straight bore or tapered bore with adapter. You can benefit from extra features such as lubrication groove and oil holes, or selected outside diameters.

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- long, dependable service life

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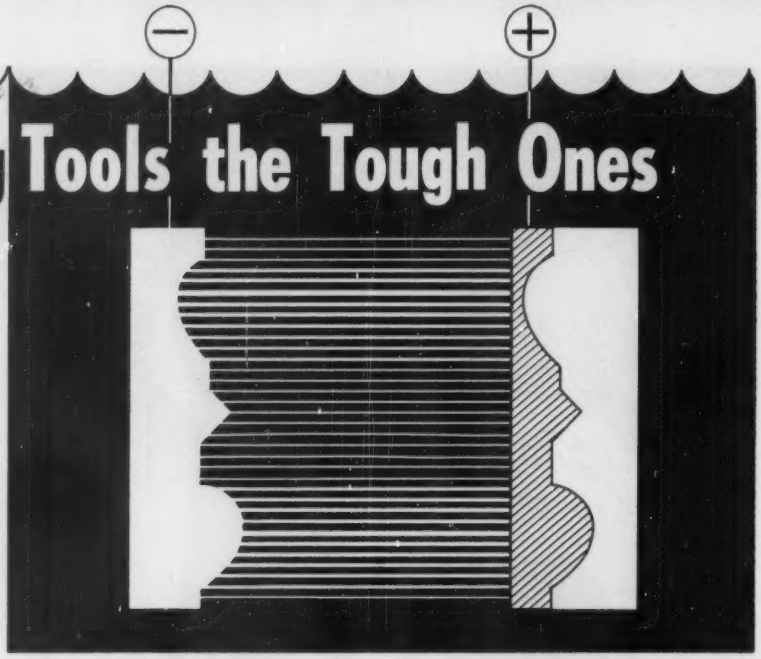
Electroshaping Tools the Tough Ones

CLEVELAND—Arcs, sparks, and high temperatures have been eliminated from electrochemical machining by a process that forms complex shapes as readily and rapidly as simple ones, and maintains a high degree of accuracy over the whole piece.

Battelle Memorial Institute developed the process for Steel Improvement and Forge Co., Cleveland, which now uses it to form turbine blades from "unworkable" metals. Electroshaping can be used to advantage on many materials, including carbides, and carbon steels.

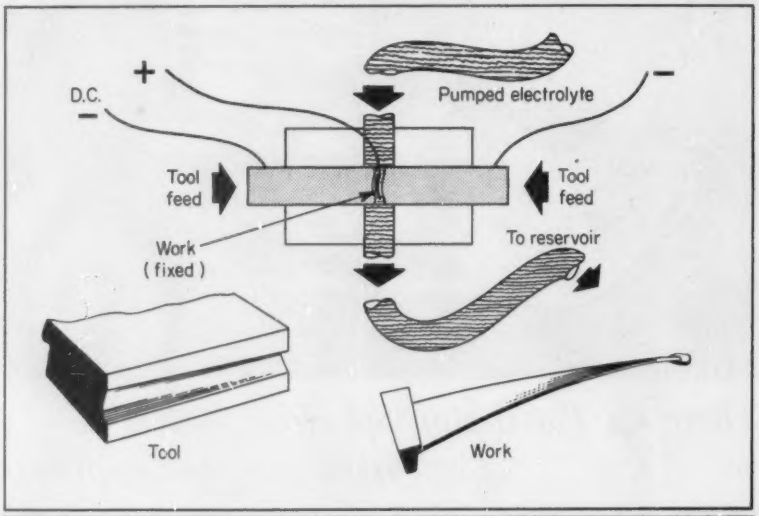
Since there is no tool pressure on the workpiece—in fact, no physical contact occurs—the process is silent. Very thin sections can be shaped without distortion, and there is no surface hardening associated with the operation.

According to Battelle's Dr. Charles Faust the new electromachining process differs from previous methods in that it produces complete, three-dimensional parts, using simple dc power, without complicat-

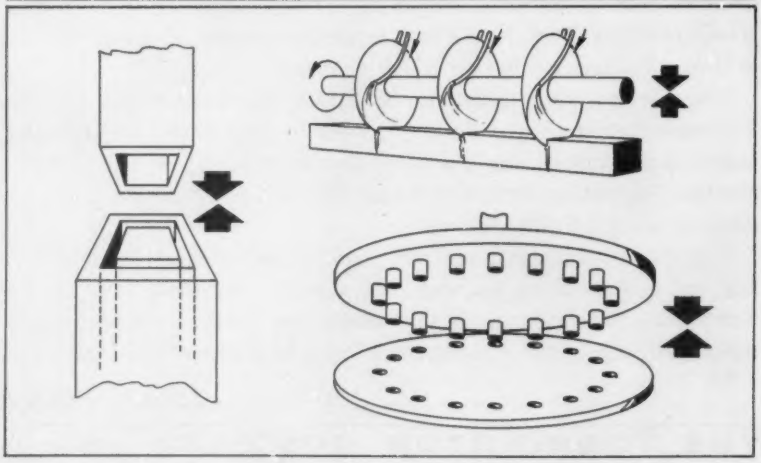


Simple conditions for electroshaping are met by connecting the workpiece to the positive terminal of a dc power source and completing the circuit through an electrolyte. Metal removal is proportional to current density at the anode surface, which depends in part on its distance from the cathode. With suitably shaped cathode electrodes, any desired three-dimensional shape can be formed.

Normal current density is about 3 amp per sq in., corresponding to removal rate of 0.0002 in. per min. To increase current density, the process by which metal atoms in solution diffuse away from the anode is speeded up by pumping the electrolyte very rapidly past the anode and dumping it in a reservoir. This permits current densities to be raised to 1500 amp per sq in.

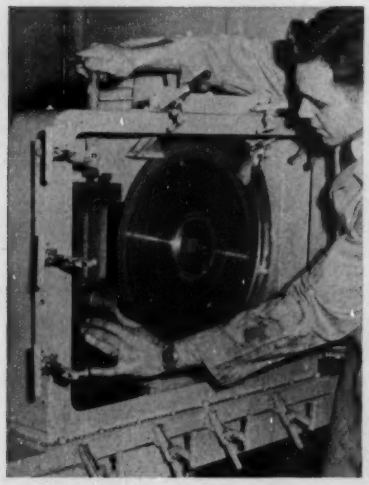


Trepanning, multiple hole drilling, and multiple cutoff are machine-shop operations that can be performed accurately, quickly, and cheaply by electroshaping. In contrast to other methods of metal removal, best finish and greatest dimensional accuracy is obtained at the highest speed. Fully hardened steels can be cut without surface damage or tool wear; the softest alloy can be worked without danger of distortion.

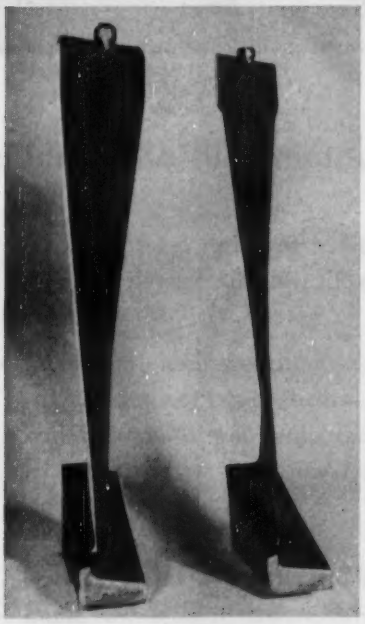


ed electronic circuits or rotating cutting tools.

Current requirements for the machines range up to 1500 amp per sq in. of working surface at from 3 to 12 volts, and penetration rates of about 50 mils per min can be maintained. Most operations are accomplished with current densities of less than 500 amp per sq in.



Rapidly rotating 1/8 in. stainless steel cathode spins electrolyte onto the tungsten-bar anode to complete the electric circuit. Although there is no contact between the bar and the wheel, cutting is accomplished at a rate of about 5 mils per min, and the resulting surface is extremely smooth.



New electroshaping process is being applied on a production basis to form "space age" metals into airfoil sections for jet-engine turbine blades.

DRAFTING TRENDS

In a typical application of the POST Diazo Materials Selector Chart, a draftsman, supervisor and reproduction specialist solve a special print-making problem in short order.

Solve unusual reproduction problems with new Diazo Selector Chart

Keeping up with rapid developments in graphic reproduction and communication techniques is a difficult job these days, even for the experts.

From the engineer's and draftsman's point of view, it's largely a matter of sorting out the specific information which helps him do a better job.

The new Post Diazo Materials Selector Chart does just that—provides a condensed, tabular reference piece that helps you anticipate the ideal diazotype prints for various needs before they occur. This convenient chart gives brief information on sensitized papers, intermediates and specialties in terse "what, when, why and where" style.

If you're concerned, for instance, with print distribution to different departments, units or groups, then prints on a variety of colored stocks might be the answer.

Increasing print production from diazo equipment with a lower-power light source . . . making legible prints from worn old tracings . . . even making copies from an opaque print . . . all can be handled by use of new Post 206M-14, a fast, extra-sensitive whiteprint paper.

Suppose a design conference calls for a poster, actual size, made from a large engineering drawing, rigid enough for display, tough enough for extreme handling and on-the-spot sketches? Post diazo-sensitized cardstock in 32 or 50 lb. weight can turn the trick on standard reproduction equipment, ammonia process or semi-moist. For many more helpful solutions to similar situations, ask for your personal file-size copy, of the Post Selector Chart, available from your Post dealer or Frederick Post Company, 3652 North Avondale Avenue, Chicago 18, Illinois.

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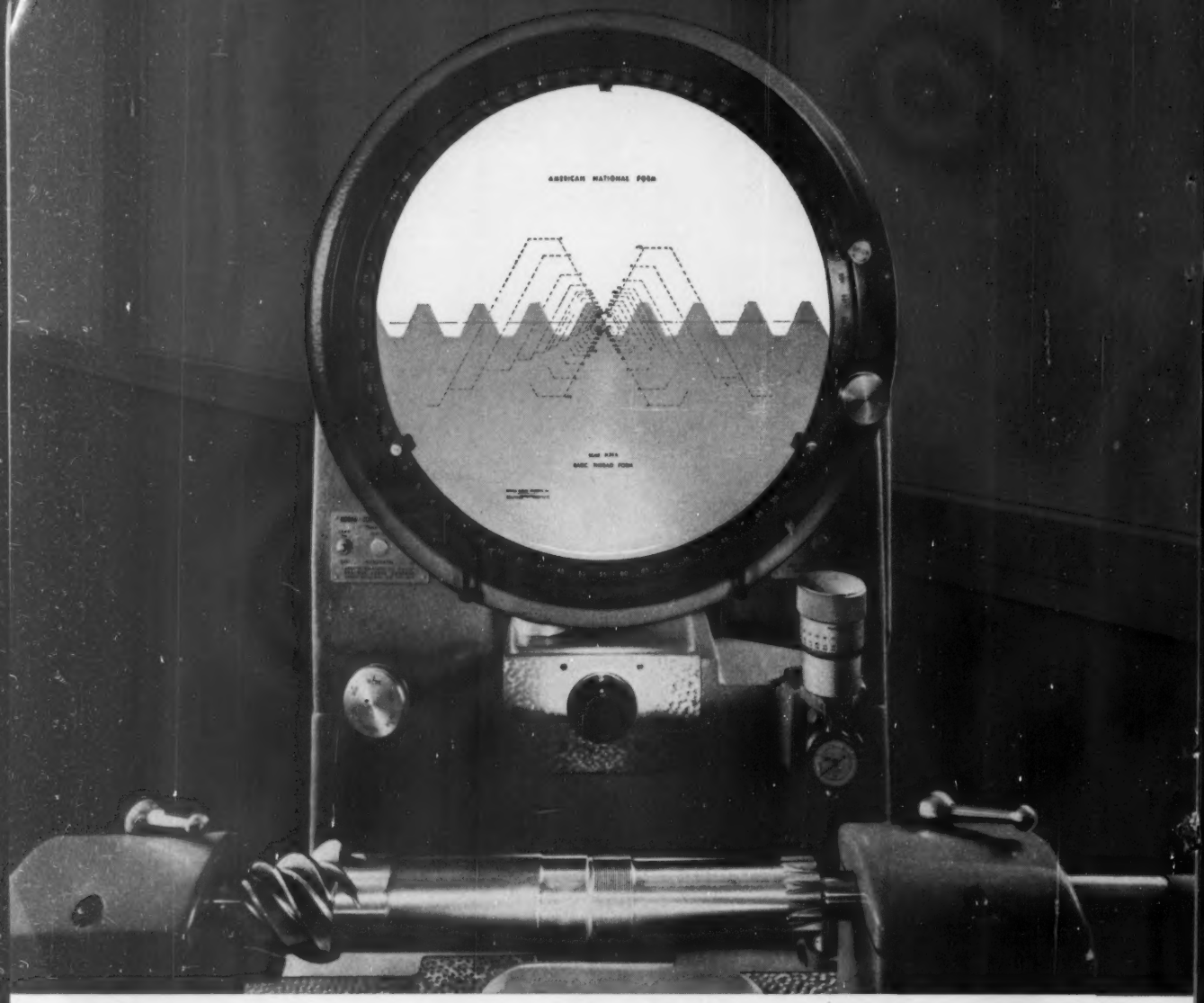

BETTER GEARS by making mountains out of molehills

This optical comparator is doing just that. The threads on the pinion in the foreground are magnified 31.25 times on the calibrated screen for intensely accurate inspection.

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CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

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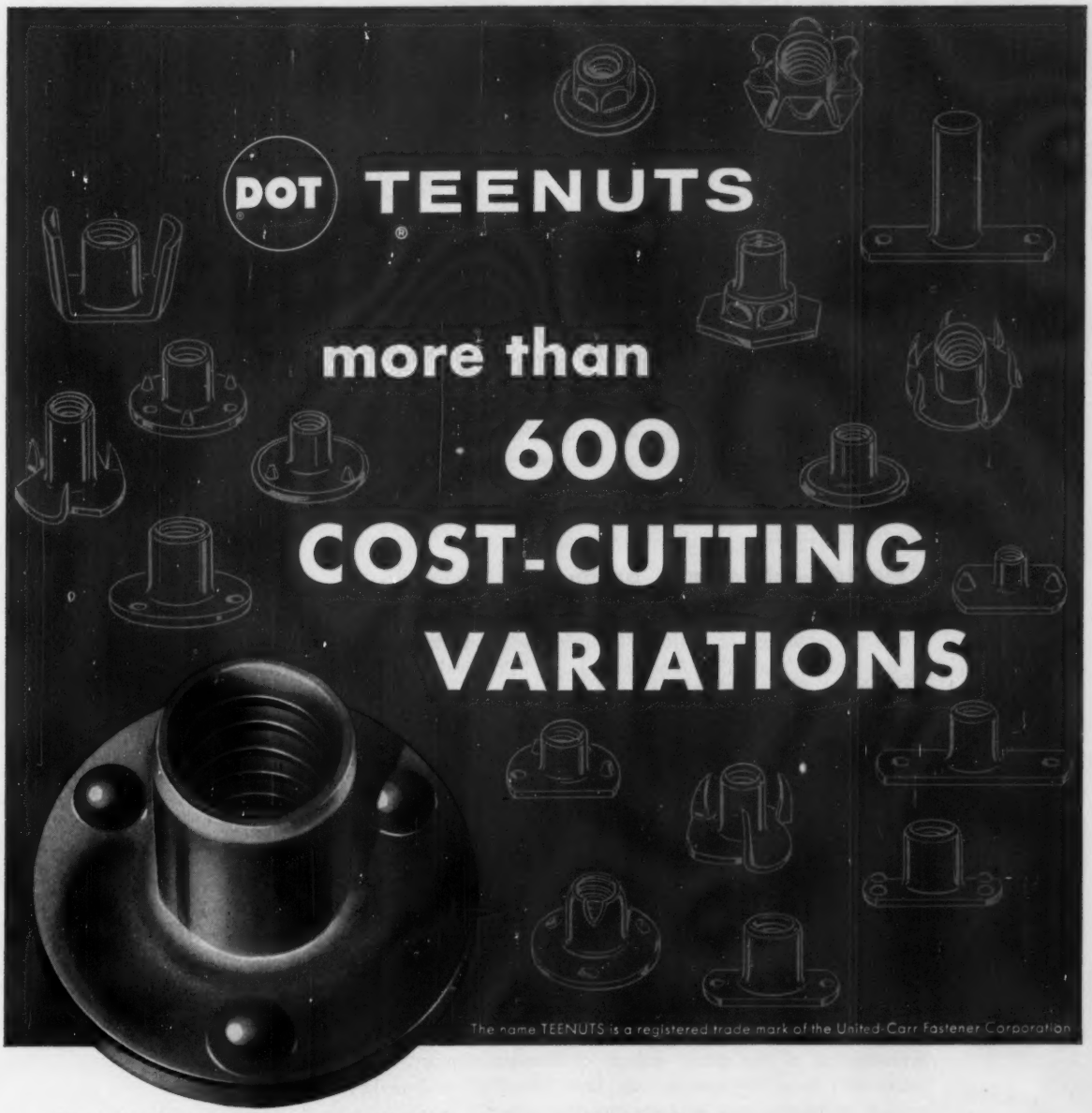

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NEWS TRENDS

too much weather data from space?

Development of a meteorological-satellite system may prove to be a wasted effort, reports an advisory committee of the National Academy of Sciences. No organization in the world is prepared to exploit the wealth of weather information that will be received. Data-handling problems will be extraordinary: Information obtained in one day will be comparable to the total accumulation of weather data since the beginning of scientific meteorology. NAS is taking steps toward organization of a weather center, but size of the center has not yet been decided.

help wanted—ultrasonics graduates

The biggest obstacle to "straight-up" growth of the ultrasonics industry is the acute shortage of trained acousticians, says Robert L. Rod, chairman of the board, Acoustica Associates Inc. "Practically no one teaches ultrasonics, and only a handful of men leave graduate school each year with even a theoretical picture of the art as seen by a physicist." Everybody started someplace else, learning ultrasonics the hunt-and-try way. The people doing ultrasonic work involving transistors, transducers, and circuit analysis usually have degrees in chemistry, metallurgy, civil engineering, or other not-too-closely related subjects.

automation in the file cabinet

File systems which "think for themselves" may result from new research at Electrada Corp. The work, sponsored by the National Science Foundation, will get underway with an exploratory look at new ways of organizing files. Teams of scientists, engineers, and psychologists will pool their skills in an investigation of the many aspects of human memory. Object of this first phase will be a file system that sorts, classifies, and makes available great masses of information without outside help.

coming: computers that "read" spoken English

Data-processing speed will soon catch up with even the fastest computers. According to Sidney M. Rubens, manager of physical research, Remington Rand Univac Military Div., many improvements are foreseeable by 1975. Among them are direct human verbal input of data, photoelectric reading of printed information, and rapid-printout devices based on tunnel diodes and other new components that are fast becoming off-the-shelf items. Remington Rand is already building an experimental memory to store one thousand 24-bit words within a cycle time less than one microsecond. But progress with thin magnetic films is so rapid that by the time this memory is completed it will probably be outdated.

tinkering with turbines no problem to airlines

Flight "squawks" by airliner crews over minor jet-engine malfunctions are running only 5 to 10 per cent of the rate normal for piston engines, reports an SAE panel. On all counts, turbine-engine performance seems to be exceeding expectations of operators and engine builders. Adding up credits and debits for the jets, the panel said that time between overhauls is growing at a "spectacular" rate—2 to 2.5 times faster than for piston engines. In-flight shutdowns have also been cut significantly, and engine failures (leading to premature removal) are half that for piston engines. On the debit side, the panel pointed to the sensitivity of the jet to fuel contamination, dangers of foreign-object entry, and expensive overhaul procedures.

executive jobs tougher to find

Big business is looking for fewer high-paid executives than it was six months ago, according to a survey of 133 large companies. Conducted by Executive Manpower Corp., New York, the survey showed there would be only 2.2 top-job openings ($10,000-75,000 per year) in each company in the next half year. Six months ago the average was 2.5, and one year ago it reached 3.5. Sales executives are the most wanted, then manufacturing/production specialists, and third, general management-administrative men. The need for engineering executives fell from second place (six months ago) to fourth.

creativity (continued)

Engineering education must do more to stimulate creativity and imagination, says Dr. Robert D. Stout, dean of the graduate school, Lehigh University. Chief concern isn't the number of engineers available; ability to translate new concepts provided by the scientists is the really scarce item. To develop creativity, Dr. Stout suggests the engineer and scientist improve communication with each other. He calls for a "blend of disciplines" and urges integration of curricula—"courses to pull together the packets of knowledge for engineering usefulness."

say something in algebra

ALGOL—the international language of mathematics—has been harnessed in a new Burroughs automatic programmer. This means that engineers with no computer training can now set up their own problems. The programmer, first to apply the *algorithmic language* (ALGOL) formulated in Switzerland in 1958, enables a computer to automatically translate algebraic symbols into machine notation. According to Burroughs spokesmen, the system cuts programing time by 80 per cent, reduces operator training time to a few hours.

A survey for the engineer

YOU AND

Part 1—

SUCCESS OR FAILURE of the movement to unionize engineers depends on the engineers themselves. They raised the issues, and they'll ultimately endorse the program that best meets their needs—whether sponsored by union, management, or professional society.

The engineering-union concept is still too new to permit accurate long-range prediction of its future. The unions may be gaining strength, but the experiment is still at a very early stage. Managers, shaken by the threat, are moving fast to counteract union arguments; whether their efforts are effective remains to be proved.

Management and professional societies tend to stand together in fighting down the several types of unions that now exist. Likewise, the unions—though their plans of attack vary—are closely allied in their struggle. The engineer has only a limited number of choices available.

High-Plane Professionals

The technical societies claim that, since the engineer is a professional,

on the fence:

THE UNIONS

What are the choices?

he must choose the "professional values"—dedication, independence, contribution to society, etc. The primary consideration is betterment of mankind, regardless of tangible rewards. Judged in this light, collective bargaining, say the societies, places primary importance on a secondary goal (material benefits) and restricts, rather than enhances, freedom and satisfaction.

To improve the engineer's lot, technical societies are fostering better understanding and co-operation between engineers and management. They are conducting educational campaigns and encouraging formation of informal sounding boards.

Managements' Tonic

Although agreeing generally with the professional societies, managers take a slightly less extreme position on the matter of rewards. They endorse the professionalism concept, but acknowledge that the engineer has the right (and often has good reason) to be concerned with his economic well-being. Managers want to be fair, but they insist collective bargaining is not the answer.

Along with the professional societies, management plans to combat the unions by improving engineer-administrator relations. Their program also gets at the heart of two secondary problems—employee turnover and effective utilization of manpower. The main effort is aimed at bridging gaps in communication channels, giving the engineer-employee more chance to freely discuss his dissatisfactions.

Shades of Gray

The engineer may not agree with either management or society points of view; he may decide some degree of collective action is necessary. Even so, he still need not accept full-fledged unionism. All engineering unions, in fact, do not recommend complete unionization. Some omit many aspects of traditional unionism in attempting to create a more refined atmosphere—one that is more compatible with the professionalism concept.

Advocates of the strong union, on

Rounding up the viewpoints of company administrators, union leaders, and professional-society officials, a ten-man team* from Harvard's Graduate School of Business Administration has shed new light on collective-action groups for engineers. Their report, *Engineers and Unions*, points out some of the directions the movement is heading. This series of articles summarizes the findings.

*Roger M. Atherton, Jr., S. Marc Altman, Lincoln Ames, K. Leo Ahlstedt, Albert E. Block, Jr., Ivan H. Enstrom, Jr., Richard D. Lockhart, Theophanes G. Pantazelos, John A. Smith, Robert T. Spahr.

Who Are the Unions?

Thirty unions (located principally in California and New York) represent technical personnel today. They bargain for some 65,000 members, but only 41,000 (63 per cent) are professionals. Since reliable sources seem to agree that about a million professionals work in the United States, the number unionized appears small—about 4 per cent.

For purposes of classification, the unions can be broken down into five types:

- Engineers and Scientists of America: A federation of seven unions that represents 24,500 people (90 per cent professional).
- Engineers and Scientists Guild: An offshoot of ESA containing nine unions and representing 17,000 people (70 per cent professional).
- American Federation of Technical Employees: The largest engineering union associated with AFL-CIO, AFTE represents 15,000 people (7 per cent professional).
- Five small unions associated with AFL-CIO, representing 2500 people (66 per cent professional).
- Eight independent unions, representing 5700 people (74 per cent professional).

Largest and most highly professional of the union groups is the Engineers and Scientists of America. This federation represents 54 per cent of all the unionized professionals. Formed in 1952 with eight member unions, ESA has failed to attract many new unions: While membership was as high as 50,000 in 1956, it has now dropped to half that number. One reason for the decline is a controversy over the relative merits of professionalism and unionism. Tighter eligibility requirements resulted and several member unions withdrew to form their own federation—the Engineers and Scientists Guild.

Organized in 1957, ESG gives two reasons for defecting from ESA: 1. The shift to a rigid definition of the professional requirements for membership. 2. De-emphasis on the collective-bargaining function. The ESG, however, has never developed to the point where it could effectively conduct collective bargaining. The primary reason, beyond the usual organizational difficulties, has been that the small unions in ESG have feared the power of the one large member, the Engineer's and Architect's Association, representing 55 per cent of the total membership.

the other hand, claim the engineer must "pull out all the stops" if he is to realize his desires. Pointing to the successes of craft and labor unions, they maintain that many benefits presently shared by all engineers arose from concessions originally obtained by engineering unions.

Factors Behind the Choice

From these alternate doctrines, the engineer must make a choice. What he does will depend on the extent and nature of his dissatisfactions, how well management treats him, his self-concept, and the character of the collective bargaining group (if any) he is considering.

Collective action can improve salary and working conditions, but it can't get at all the causes of dissatisfaction. One of the engineer's wants, for example, is greater respect from his employer and peers. This is the kind of problem that management is inherently well equipped to handle, but unions find it most perplexing. Union leaders realize that if the engineer is to react favorably to unionization, techniques must be developed for handling all his problems—not just those that lend themselves to collective bargaining.

Problems for Managers

In some companies, an atmosphere of impersonality exists—often because of the numbers of people employed, often for other reasons. Policy discourages employees from dealing directly with anyone having authority to act on their requests. The engineer working for such a company may feel that as an individual, his bargaining power is insignificant. He may conclude that his employer does not care about an individual's problems.

Managers' problems are additionally complicated by the different values that differentiate the business and engineering worlds. Engineers' expectations arise from their technical values, but rewards, distributed by businessmen, are determined by business values. The two viewpoints often lead to conflict. Engineer and businessman each feel the other is unreasonable.

If he feels management isn't giving his complaints adequate attention, the engineer will be likely to consider collective action. By encouraging discussion of a grievance and attempting to understand the complaint, managers can effectively counteract the union movement. But managers and engineers must recognize the conflict in values—they think differently and must work problems out together. Any other procedure leads to a settlement that is not satisfactory.

Professionalism Defended

Because he sees himself as a professional, the engineer tends to reject collective bargaining. Unions present strong arguments, but the engineer usually remains unswayed.

Professional status is due for definition in the courts, however, and judicial precedent is being set in trial cases. Perhaps additional legislation will clarify the term. It's possible that some engineers will not be legally recognized as professionals.

Because the title of engineer has come into such broad usage, covering a multitude of jobs, responsibilities, and activities, it no longer accurately describes anyone. A more reliable basis for professionalism is the job done by an individual. If this criterion is adopted, engineers who can't qualify may find new interest in the union movement.

Professionalism does not insure that the engineer won't join a union. If his dissatisfactions are high, he may think management is taking advantage of him. Unable to obtain what he deserves, he may feel forced to endorse collective action to protect his concept of status.

The final factor influencing the engineer is the character of the collective-bargaining group. He will be little inclined to join a group if its platform conflicts with professionalism. He tends to favor a refined atmosphere that bolsters his own impression of high status.

Clauses in the Contract

Several engineering unions, notably the Engineers and Scientists of America, have stressed professional status in collective-bargaining agreements. These unions frequently request a contract requiring the employer to pay professional-society dues for the engineer-employee. The importance of this type of clause is considered much greater than the money involved (which may be negligible): Unionized engineers believe the provision is one method of securing employer recognition of their status.

Other contract clauses often include:

- Leave of absence with pay for engineers wishing to attend professional-society meetings.
- Tuition refunds for engineers taking university courses connected with their work.
- Leave of absence without loss of seniority to engineers wishing to further their education on a full-time basis.
- Provisions covering the signing of patent agreements, including definition of the patent agreement and treatment of the different types of inventions covered in the agreement, amount to be paid to the inventor, role of the union, and procedures for settling patent disputes.

People join unions, psychologists say, for security, recognition, and "belongingness" that they do not get from their employers. Capitalizing on such desires, unions claim they can fill the gap—even if they do no more than force managers to help the engineer escape from the "mediocrity of mass employment."

Part 2 in this series, appearing in the November 24 issue of MACHINE DESIGN, will report in detail where the unions stand today and what their plans are for the future.

How the Door Opened

The Wagner Act, coming in the middle of the depression, guaranteed the right of collective bargaining. But the Act provided no distinction between professionals and other employees; engineers found themselves becoming minority groups in unions that did not represent them. To rectify the situation, engineers formed their own unions and negotiated for interpretations from the National Labor Relations Board.

While NLRB had the power to recognize engineering groups as separate bargaining units, it was slow in doing so. The board admitted the professional nature of engineering, but it did not deem professionalism a sufficient reason to distinguish engineers from other employees.

World War II ended much of the friction; after the war, labor laws were reviewed. Professional societies beseiged Congress with distinctions between professionals and nonprofessionals and put on pressure for legislation to protect engineers' collective-bargaining rights. The result—incorporated in the Taft-Hartley Act—was a fundamental change in labor law that affected subsequent developments in the engineering-union movement: Originally, professional unions had been formed for defensive reasons, but now the unions started thinking aggressively.

Data Double-Checker

Presents Data on Demand For Visual Editing by Operator

BEVERLY HILLS, CALIF. — A new man-machine link slows down computer read-out and displays it visually without slowing down computer operation. The device permits a machine operator to double check information before it goes into a data processor, or to correct information being relayed from one point to another in a computer system.

Datacom, developed by Electrada Corp., accepts digital information at line speed, automatically translates it to alpha-numeric characters, and presents it as a clear display on a cathode-ray picture tube. As information is displayed, all or parts of it may be approved by the operator, or "edited" through a standard typewriter keyboard. The operator can correct and expand incoming messages, compose, transmit, and receive information, or send prerecorded, stored messages.

A magnetic memory drum stores information for the display screen, and holds it ready for editing or transmittal. Size of the memory can be tailored to the application.

Datacom may be incorporated into any existing data processing or communications system. Auxiliary devices, such as a buffer memory that accumulates messages in periods of peak activity and releases them as required, are also available.

Displayed information transfers from the upper portion of the screen to the lower as it is edited. Two small marker lines indicate the position of the character ready to transfer and its subsequent location.

AMA Study Finds No Standard in Manpower Utilization

NEW YORK — Wide variations in manpower efficiency are revealed in a nation-wide study of leading corporations just completed by the American Management Association.

Economies already effected by several of the participating companies since preliminary figures became available range from $36,000 a year for a single operation in one company, to more than $1,000,000 annually by another. The survey is described by AMA as one answer to the profit squeeze.

Variations of 50 per cent in manpower used to perform standard administrative tasks are common, the study shows. In two industry groups, variations of 200 and 500 per cent were discovered in general administration work. One company found it had 700 per cent more employees in personnel work, in proportion to the total work force, than another corporation in the same industry.

The study, named AMA Group Ten Research Project, is a co-operative, pioneering project in self-appraisal by 88 corporations employing more than one million people. It is the most comprehensive analysis ever attempted of effective manpower utilization. Several of the participating companies have an annual sales volume of more than $1 billion.

Major industry groups represented in the project include metal fabricating, aircraft, machinery, electronics, electrical machinery, food, paper and textiles.

Originally designed by AMA to investigate numbers and ratios of administrative employees, the study now provides meaningful comparisons among many additional classes of workers.

Variations in the per cent of total employees in major corporate functions are illustrated in the following table, which compares the high and low industry-group figures with the average for all 88 companies:

Who Does What?

Function	Percentage of Total Employees High	Low	Average*
Manufacturing or processing	71.5	45.0	59.68
Design, development, research	26.6	3.9	14.71
Marketing	24.1	3.5	11.87
General Administration	14.0	8.7	10.58

*Less than 100 per cent total; minor subclassifications omitted.

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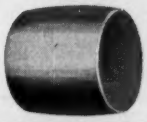


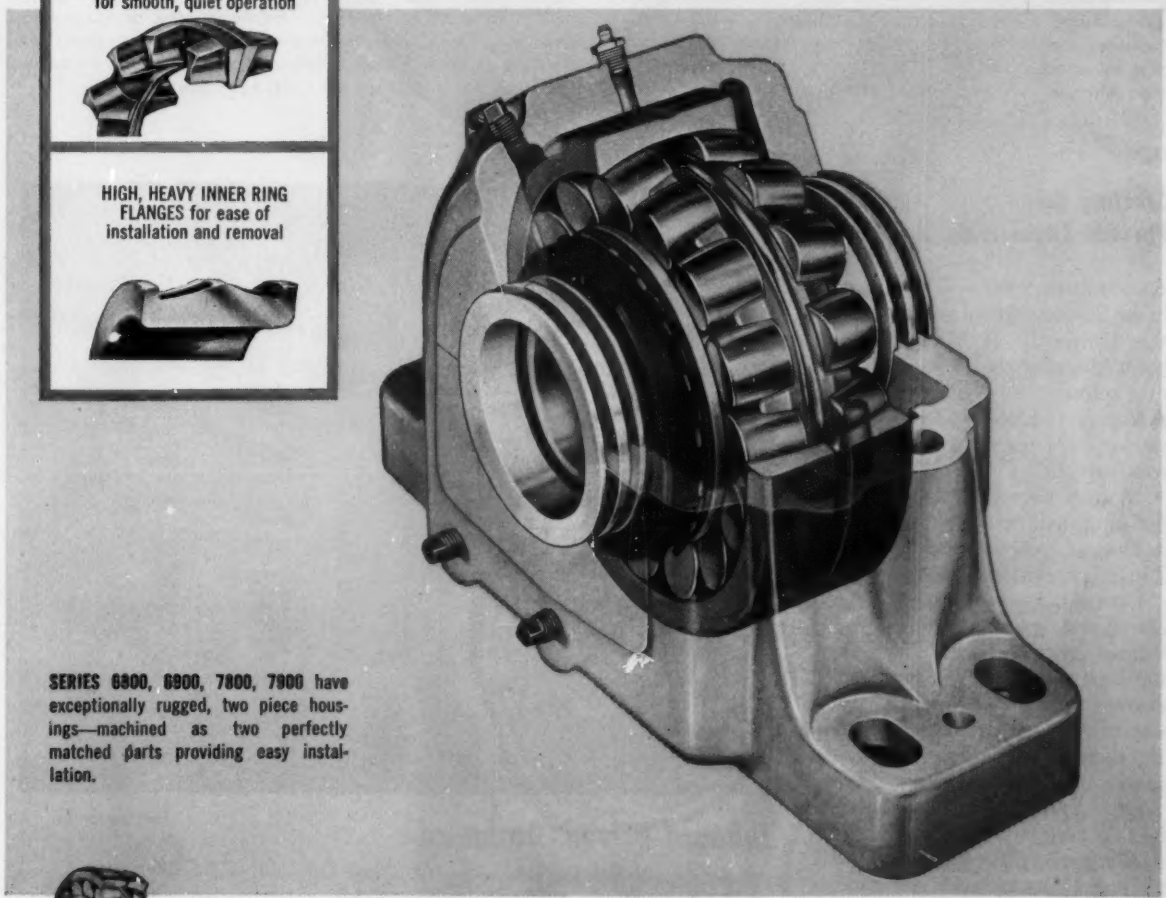
CENTRIFUGALLY CAST, PRECISION MACHINED BRONZE RETAINERS for smooth, quiet operation

HIGH, HEAVY INNER RING FLANGES for ease of installation and removal

AND INSIDE LINK-BELT ROLLER BEARING BLOCKS you'll find Link-Belt's new spherical roller bearings . . . with big, mirror-smooth, highest capacity rollers; centrifugally cast, precision machined bronze retainers; heavy, broad-shouldered inner rings. *All* the best features of modern bearing design compactly unitized for utmost economy and long service life.

Link-Belt spherical roller bearing pillow blocks are self-aligning. Available in adapter mounting and direct-shaft mounting types for shafts from 1 7/16" to 12". Choice of two effective seals: all-purpose steel, multi-labyrinth seals, or Dacron-contact seals.

For full details, call your nearest Link-Belt office. Look under BEARINGS in the yellow pages of your telephone directory. Ask for Book 2760.



SERIES 6800, 6900, 7800, 7900 have exceptionally rugged, two piece housings—machined as two perfectly matched parts providing easy installation.

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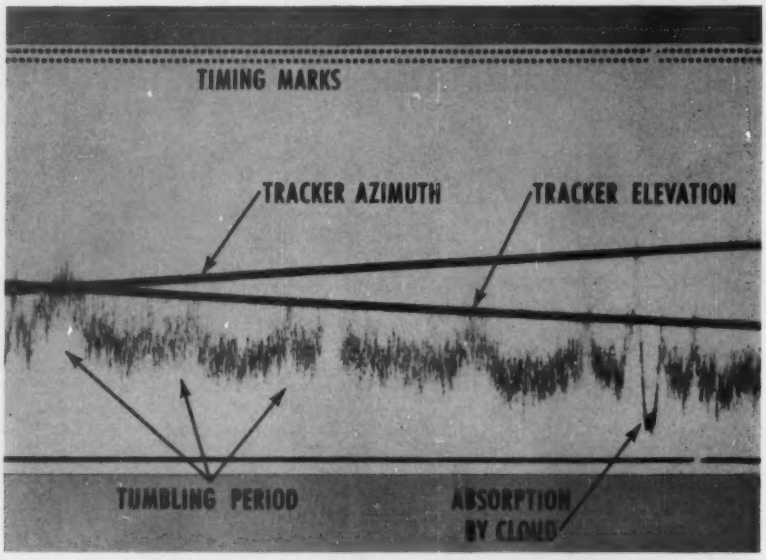
Portable Satellite-Tumble Tracker



Tumble-tracking system (left) plots data on satellite tumbling by recording changes in light reflection. In communications satellites, tumbling prevents continuous signal transmission, and in manned vehicles it may cause serious discomfort to the astronaut. The portable instrument—the first ever to collect tumble data (right)—follows the target automatically. Raytheon Co., Waltham, Mass., claims the new device is also ideal for space-ship navigation where weight limitations restrict use of radar. It occupies less than 8 cu ft, has no bulky transmitter, and requires only a 6-in. mirror "antenna."

Starting Salaries Up Again For UM Engineering Graduates

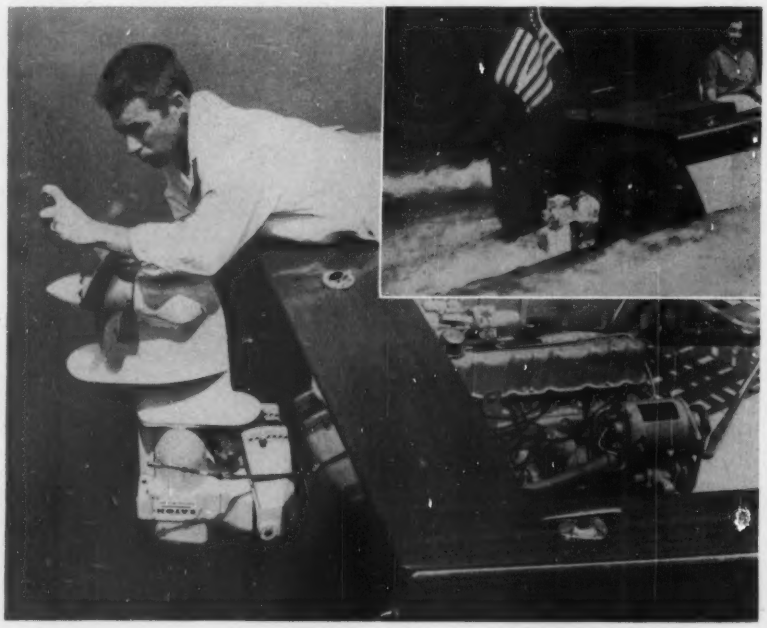
ANN ARBOR, MICH.—The '60 crop of engineering-school graduates from the University of Michigan commanded higher starting salaries than ever before:

- Bachelor-degree holders took jobs paying $524 per month (up 2.3 per cent over 1959).
- Masters' degrees brought offers of $655 per month (up 9.5 per cent).
- Doctors received $858 per month (up 6.5 per cent).

Greatest demand was in the research and development areas, as indicated by the better offers made for high scholarship and advanced degrees, reports Prof. John G. Young, director of engineering placement. But demand in the design and application area was also strong.

Other trends were noted by Professor Young:

- A larger number of students chose to begin employment in training programs, rather than by direct assignment to specific activities.
- The number of students choosing medium-sized companies (500 to 5000 employees) almost doubled.



Inboard-Driven Outboard

Advantages of inboard and outboard power are combined in the latest marine drive that brings the shaft through the transom above the water line. Designed by Eaton Manufacturing Co., Cleveland, the "Powernaut" can be rotated (upward) 180 degrees or removed for maintenance and trailerizing. It also permits the engine to be mounted in the stern of the boat, giving inboards increased usable "living" area. The drive can be adapted to a variety of inboard marine engines. Typical installation (in a 19-ft boat) is shown above.

Kodak

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IN MOLDED THERMOPLASTIC

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The versatility of Quinn-Berry engineering and craftsmanship demonstrates itself again in this Kodak Slide Tray of molded thermoplastics.

Dimensional stability plus the meeting of exacting tolerances for the slide guides characterize the requirements of these Kodak Cavalcade Projector Components. Slides must move through the projector smoothly and noiselessly—any possibility of chatter or jumpiness must be avoided.

Careful choice of thermoplastics, skilled precision mold design and dependable, experienced press room operation . . . these are the "ingredients of success" in producing parts to meet the demands of the popular Kodak Cavalcade Projector, "Finest of The Automatics".

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Circle 414 on Page 19

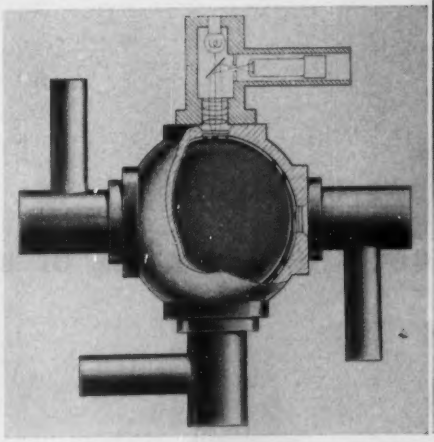
ENGINEERING NEWS

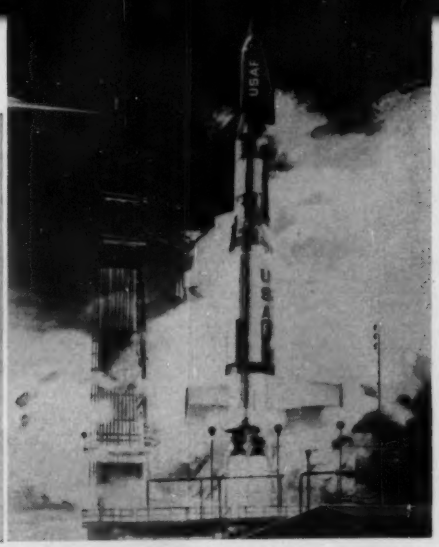
PICTURE REPORT

A plastic transparency, made in normal light in less than ten seconds, can be projected immediately in a fully lighted room. The new Thermo-Fax system, developed by Minnesota Mining & Mfg. Co., utilizes a copying machine and an overhead projector. No chemicals or solutions are used.

Keeping an information-transmitting system literally under his hat, a pilot or astronaut can be tuned in by ground-station recorders which keep tab of his physiological reactions. Packaged in a flight helmet, a telemetry system built by Vector Mfg. Co. Inc. has channels to transmit brain waves, heart-beats, and data on respiration. It uses three low-level amplifiers, three subcarrier oscillators, and a crystal-controlled transmitter.

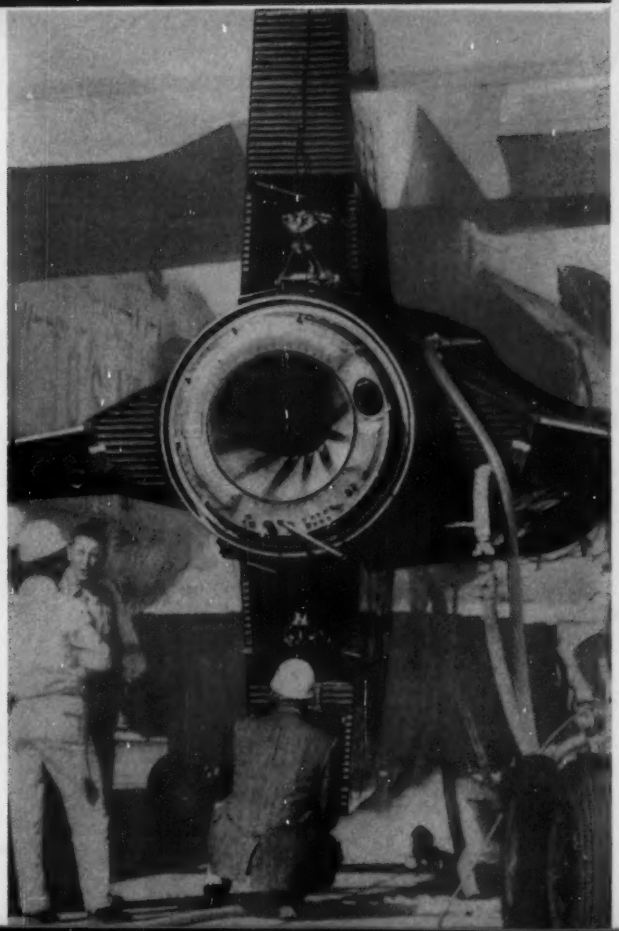
The one moving part in Minneapolis-Honeywell's new gyroscope is its spherical gyrorotor. This sphere, electrically suspended in a vacuum, spins virtually without friction. Information on the gyro's position is piped through extensions by optical pickoffs, as shown in the cross-section. Under development by Honeywell's Aeronautical Div., the gyro is for possible use in submarines which carry Polaris missiles.





Pilot control is being added to Titan ICBM rocket engines by Aerojet-General Corp. so that they can be used as boosters for the Dyna-Soar. By means of monitoring circuits, the pilot, ground stations, or an automatic system will be made aware of changing conditions and will control the engines. The Dyna-Soar glider will orbit the earth, reenter the atmosphere, and be piloted to a conventional landing.

New target missile, the Beechcraft PD 75-4-1, offers improved performance over the previous model without increase in cost. Developed by Beech Aircraft Corp. and Continental Motors Corp., it has a 145-hp engine—an increase of 25 hp—and is considerably heavier than the previous target.



New engine for the X-15 replaces a smaller one. The XLR-99, with 57,000 pounds of thrust, is designed to take the North American built experimental plane to altitudes of more than 50 miles.

The Aardvark has changed

to meet the demands of survival

To make your products easy to modify design for fabricated steel

OVER the years the Aardvark has changed in many ways to survive in Nature's competition. It has developed extra heavy claws for breaking open ant hills, a long snout to reach inside, and a long sticky tongue to lick out the ants.

Now maybe your products don't need claws or sticky tongues, but chances are at times you've wished you could make a few changes easily.

When products are fabricated from steel and joined by welding, design changes are easy, quick and inexpensive. There are no patterns to change; no foundry delivery to worry about. And for those last-minute modifications for a special customer—just cut off the old part and weld on the new.

If you feel there are some areas of your company's manufacturing where you could gain a competitive advantage by switching to fabricated steel, call in your local LINCOLN Field Engineer. He won't design your product for you, but he can supply helpful time and cost-saving ideas when you are starting to change over.

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LINCOLN WELDERS

Circle 415 on Page 19

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✓ efficiently
✓ economically
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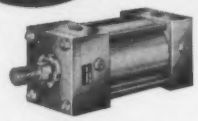

Standard Cylinders AIR or OIL Without Modification

Save money with S-P's complete line; rated 200 psi air, 500 psi oil or water; 23 mounting types; 11 bore sizes—1½" thru 14"; see Catalog 110C.

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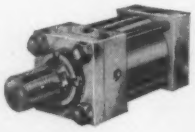

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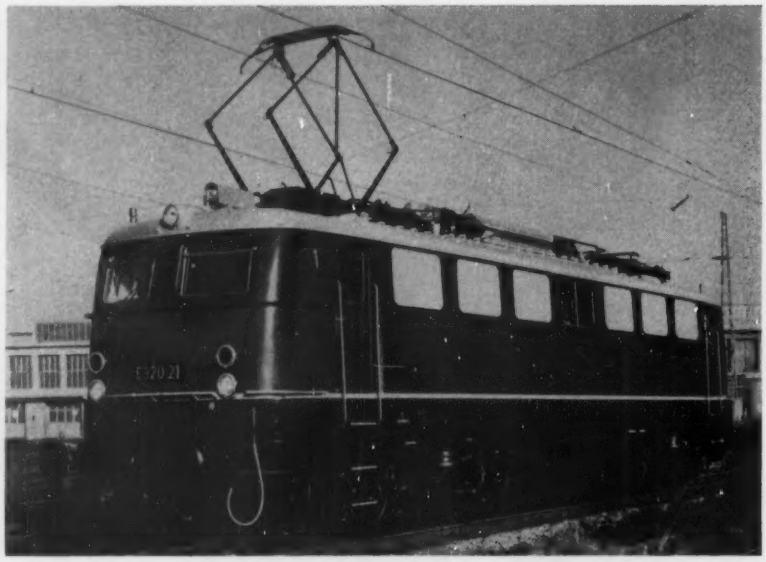


Two-Cycle Trolley

First dual-frequency locomotive—designed to eliminate border-crossing problems in Europe—operates on 15 kv at 16-2/3 cps or 25 kv at 50 cps. Rating of the 83-ton, four-axle vehicle is 2550 kw; maximum speed is 75 mph. Power for the trolley's traction motors and auxiliary circuits is provided by rectifier cells, mounted in ducts of motor fans to facilitate cooling. Two current collectors, equipped with individual shoes, permit adaption to varying arrangements of trolley wires. Built for West-German Federal Railways, the locomotive was designed by Siemens-Schuckert-werke AG, Erlangen, Germany.

Hiring Costs Go Up When Company Works for U.S.

WASHINGTON—Hiring costs and separation rates are consistently higher for companies primarily engaged in Government work than for primarily commercial firms.

Despite the stringent regulations issued following a Defense Department investigation in 1957, a report completed this summer again showed that Government contractors spend more per engineer hired, and hire more engineers than those firms engaged in less than 50 per cent Government work.

The subcommittee on Manpower Utilization of the Committee on Post Office and Civil Service, in submitting the latest report, noted that the difference between defense and nondefense company recruiting costs had narrowed considerably in the intervening two years.

The committee reported that four of the 102 firms studied spent in excess of $2000 per hire, and of these, three were government contractors. Eleven companies—all government contractors but one—spent $1500-$2000 per hire; in general, cost per hire for the group was about $900.

New engineer-hirings by the 102 firms exceeded the separation-rate, but it was found that companies working predominantly on Government contracts hired a relatively larger number of engineers during the year-long study than did the companies engaged primarily in commercial work (table).

Department	Government Firms		Commercial Firms	
	Separation Rate (per cent)	Addition Rate (per cent)	Separation Rate (per cent)	Addition Rate (per cent)
Army	21.6	32.1	14.0	21.4
Navy	5.4	20.6	12.9	14.9
Air Force	10.6	19.6	14.1	14.1

Circle 417 on Page 19→

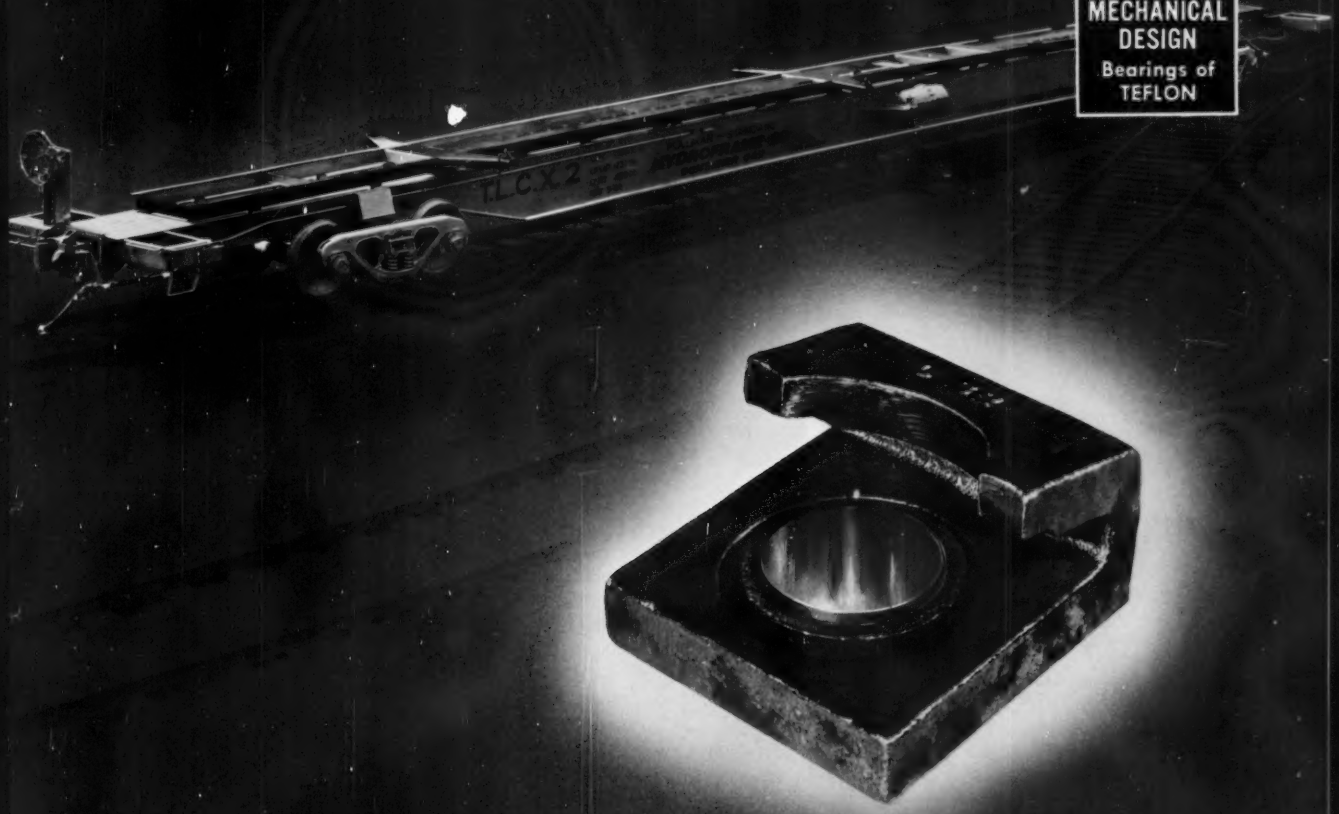
DU PONT

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER M-12
IN A SERIES
MECHANICAL DESIGN
Bearings of TEFLON



Non-lubricated anti-friction pads of TEFLON® cut bearing costs over 80% on railroad cars

On a newly designed railroad car, I-beam frames that support cargo containers ride on anti-friction pads of a filled TEFLON TFE-fluorocarbon resin. Thirty bearings, like the one shown above, permit forward and backward movement, which cushions the containers against impact. Each complete bearing of TEFLON with metal backing costs about $1.75, less than one-fifth the cost of a 5" roller bearing which would otherwise be used. In addition, the low-friction pads of TEFLON make lubrication unnecessary . . . while maintaining low break-away friction. The absence of grease prevents sticking of abrasive dirt from track bed on the bearing surface.

If *your* equipment designs involve sliding bearings, consider the money-saving advantages offered by bearings of TEFLON. Filled compositions and reinforced constructions of TEFLON are available to meet the requirements of increased loads and speeds or of high wear resistance—and TEFLON fluorocarbon resins provide dry lubrication.

On the following page you will find basic data on the properties and performance of bearings of TEFLON and the ways they make possible cost-saving design improvements.

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.

OVER

Bearings of TEFLON®: major design considerations

FIGURE 1

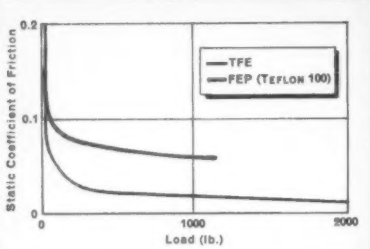


FIGURE 2

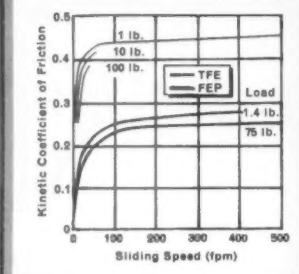


TABLE 1

UPPER SERVICE LIMITS OF VARIOUS CONSTRUCTIONS

Material	Load (psi) ≤ 2 ft. per minute velocity	Velocity (ft./min.) 100 psi load
Unmodified TFE resins	500	25
Compounded TFE resins	2,500	200
Reinforced TFE resins	40,000	1,000
Fabric of oriented fibers of a TFE resin	60,000	60

TABLE 2

Construction	Wear	Conditions
Molded TFE resins		
unfilled	200 mg./hr.	410 stainless steel shaft
25% graphite	0.7 mg./hr.	1" long x ¾" I.D.
22% glass	0.2 mg./hr.	60 ft./min. 42 lbs.
25% copper	1.2 mg./hr.	
25% graphite	0.7 mg./hr.	410 stainless steel shaft
22% glass	0.4 mg./hr.	1" long x ¾" I.D. 215 ft./min. 21 lbs.
unfilled	0.74 mg./hr.	303 stainless steel shaft
15-25 graphite	0.0015 mg./hr.	½" long x ¼" I.D.
15-25 glass	0.0015 mg./hr.	9.8 ft./min. 35 psi
4-8 copper	0.032 mg./hr.	White, H.S. National Bureau of Standards
Fabrics of oriented fibers of TFE resins	6×10^{-6} in/hr.	1" shaft 25 ft./min. 1150 psi
Reinforced TFE resins	4×10^{-7} in/hr.	1" shaft 100 rpm 2000 psi

Properties of bearings of TEFLON

TEFLON fluorocarbon resins have properties which make them excellent materials for journal, plane-surface and thrust bearings. Filled compositions and reinforced constructions are usually used to tailor bearings of TEFLON for increased loads and velocities or high wear resistance. Among the major benefits that TEFLON resins offer as bearing materials are:

1. Low coefficient of friction—The static coefficient of friction of TEFLON resins is even lower than the dynamic value. At high loads and low velocities, TEFLON resins have a lower friction than any other solid material . . . significantly lower than lubricated metal bearings. (See Figure 1 for static coefficients of both TEFLON TFE resins and the new, melt-processible TEFLON FEP resin. The kinetic coefficients of friction vs. sliding speed at 73°F. are shown in Figure 2.)

2. Temperature resistance—Bearings of TEFLON TFE resins have exceptional thermal stability and are suitable for continuous service up to 500°F. At -450°F. these resins show the same friction that would be expected for similar conditions of load and velocity at room temperature.

3. Chemical resistance—Bearings of TEFLON resins are completely resistant to virtually all chemicals and solvents. They do not absorb moisture and are completely unaffected by outdoor exposure to weather.

4. Other properties — Bearings of TEFLON resins are tough, abrasion resistant, and have the ability to embed hard foreign contaminates.

WHERE TO USE

Bearings made of TEFLON resins are being used where lubricated bearings are undesirable or incapable of operation, in extreme temperatures or corrosive conditions, or where there is a possibility of lubricant failure. They are used where safety and reliability are essential. They are used near substances that must not be contaminated; with non-lubricating liquids such as gasoline; with corrosive substances; at low or high temperatures where common lubricants are useless; under extreme conditions of humidity; in areas where there is danger of fretting or galling; where stick-slip motion is undesirable; where space or weight savings are essential.

SPECIAL CONSIDERATIONS

Load and Speed

Unfilled TEFLON resins are used in light load, low PV factor bearings. For higher loads and speeds, reinforced constructions and filled compositions of TEFLON provide the increased compressive strength, thermal and dimensional stability, heat dissipation and wear resistance required. See Table 1 for indications of the capabilities of various types of bearings of TEFLON TFE resins.

Bearing Life and Wear

Bearing life is usually dependent on wear, which in turn is dependent on load, surface sliding speed, lubrication and shaft finish, as well as clearances and construction. Hence, it is not practicable to define wear rate for all conditions. Table 2, however, is indicative of the wear rates for some typical bearing applications.

FOR MORE INFORMATION about the properties and uses of bearings of TEFLON and the new fact-filled booklet "Designing with TEFLON", write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department T-25-11, Room 2526, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

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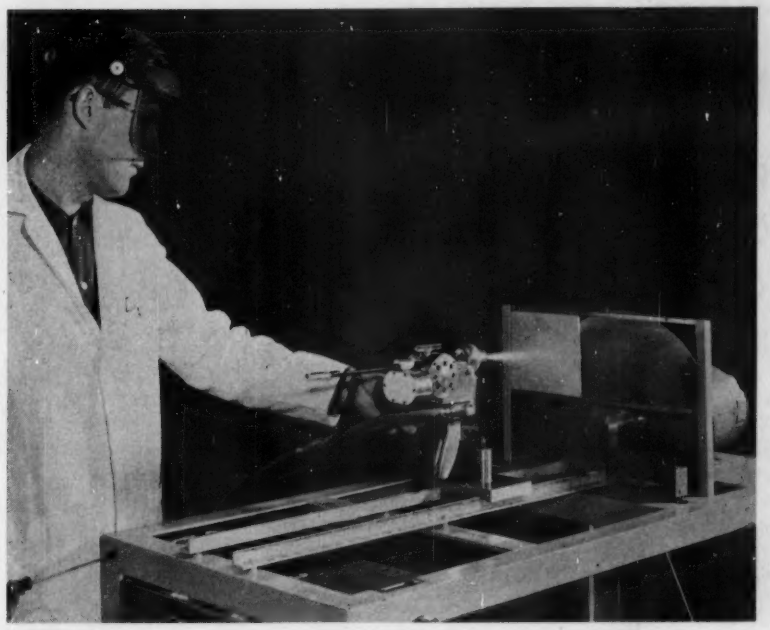
TEFLON®
FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



NBS Looks for Stronger Metal-Ceramic Bonds

Flame-sprayed alumina offers a new heat-resistant coating for metals used in rocket engines and space vehicles, says the National Bureau of Standards, Washington. The Bureau is studying both rod and powder-gun applicators in efforts to uncover important bonding factors. To examine particle velocity, NBS developed a rotating-disc velocometer to show that a stronger bond is achieved with a rod gun than with a powder gun. Calculations of alumina cooling rates suggest the 34,000 C per sec rate on glass develops a chemical bond, while the 800,000 C per sec rate on stainless steel allows only a physical bond. Further tests revealed that bond strength on metals improved considerably as surface roughness increased. Bonds, in general, seem to be largely mechanical.

Aluminum Gains in '61 Cars

DETROIT—The rash of new aluminum engines will substantially increase use of the light metal by automotive manufacturers during the 1961 model year. Kaiser Aluminum & Chemical Corp. estimates a per car increase of 14.2 per cent in its annual survey of aluminum in cars. This follows a ten-year trend of annual increases ranging from 10 to 15 per cent.

Significant developments noted in the Kaiser study:

• Estimated net weight of aluminum components will average approximately 62.1 lb per car compared to 54.4 lb per car during 1960.

• Aluminum will score its biggest advance in functional parts . . . the advent of aluminum engine blocks boosting the average functional usage 7.7 lb per car.

• The new aluminum-engine small cars will lead all models in aluminum usage at 106 to 134 lb per car.

The roster of leading aluminum users, as compiled by Kaiser, includes:

• Oldsmobile's new F-85 with 134.9 pounds of aluminum, including a new aluminum V-8 engine block. The complete engine weighs 325 lb, compared to a cast-iron engine weight of nearly 600 lb.

• The new Buick Special equipped with a similar aluminum V-8, which will use a total of 132.6 lb of aluminum.

• American Motors' Rambler powered by a die-cast six-cylinder aluminum powerplant uses 120.6 lb.

Another Fluid Regulators Achievement

NEW Cartridge Flow Regulator

- **Maintains constant flow to the system when pump output varies**
- **Assures constant flow under varying upstream and downstream pressures**

Developed and produced for use in multi-valve manifold, this small, lightweight valve eliminated connectors, fittings and lines. It reduced leakage points and weight, and permitted system design engineers greater design freedom.

Designed in close cooperation with the customer's engineering department, this valve illustrates the capabilities of Fluid Regulators to meet critical flow, size and weight requirements. Contact us today, for prompt action on your specific problems.

SPECIFICATIONS

- Regulated Flow: 0.1 gpm to 6.5 gpm with various combinations of springs and orifices. Factory Set—with limited field adjustment available.
- Regulation: ±10% for flows 0.1 to 1.5 gpm
  ± 5% for flows 1.5 to 6.5 gpm
- Pressure Drop: 25 psi at high flows — 50 psi at low flows.
- System Pressure: to 2,000 psi
- Proof Pressure: 3,000 psi
- Burst Pressure: 5,000 psi
- Weight: 4 oz.
- Temperature: —65° F. to +275° F.
- Fluids: any fluid compatible with materials.
- Materials: aluminum alloy and stainless steel.
- Finishes: aluminum alloy parts hard-coated—stainless steel passivated.
- Designed to meet MIL-V-8566
- These specifications may be changed to meet your specific requirements.

Fluid Regulators CORPORATION

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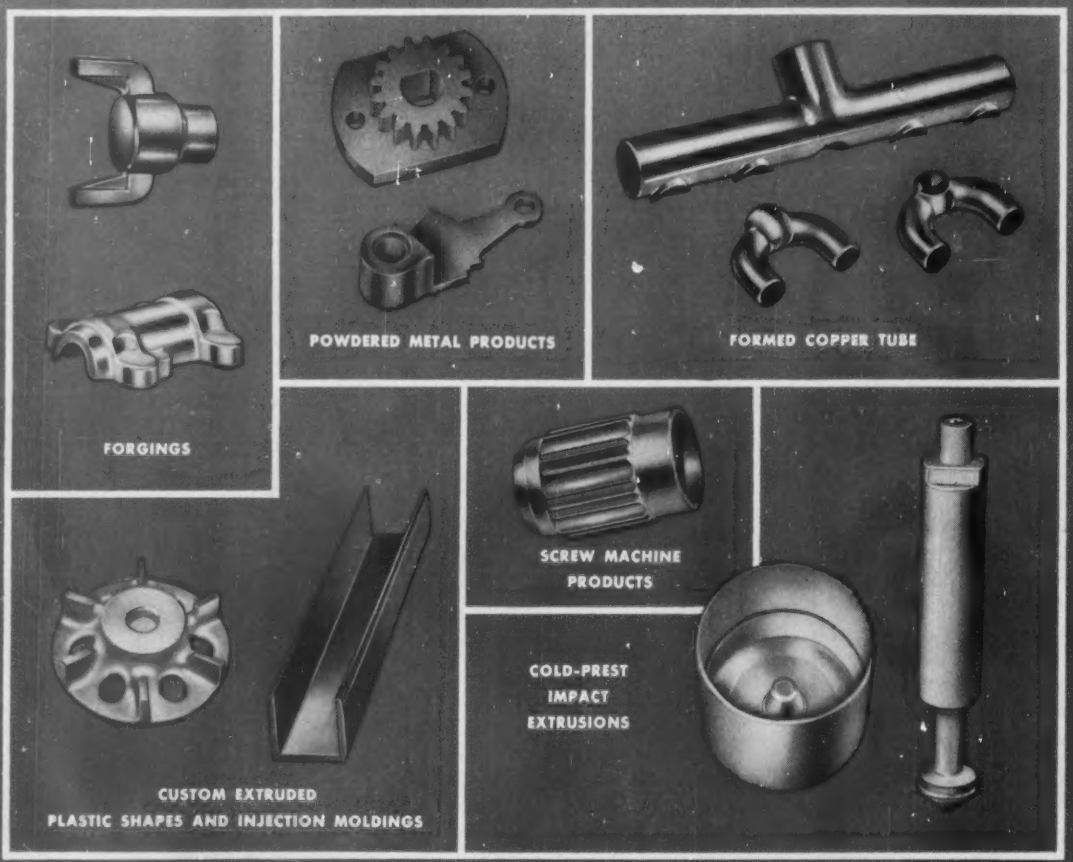
Circle 418 on Page 19

THE MAN FROM MUELLER BRASS CO.

REPRESENTS ONE DEPENDABLE SOURCE FOR PARTS FABRICATED TO YOUR SPECIFICATIONS FROM COPPER, BRASS, ALUMINUM AND PLASTICS

In today's market, the Man From Mueller Brass Co. can help you save both time and money. Mueller Brass Co. offers a variety of production methods and you get an unbiased opinion on the most practical and economical way to make your specific part . . . hence you save time in planning and engineering, and money in production. Consult the Man From Mueller Brass Co. . . . you'll find he's a good man to know . . . and Mueller Brass Co. a dependable source for fabricated parts.

Write today for information on any of the many quality products shown here.



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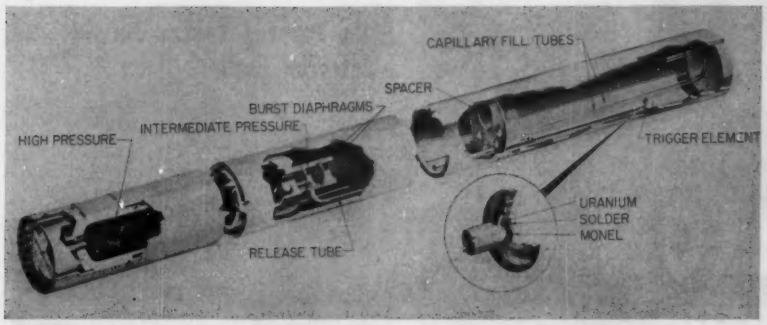
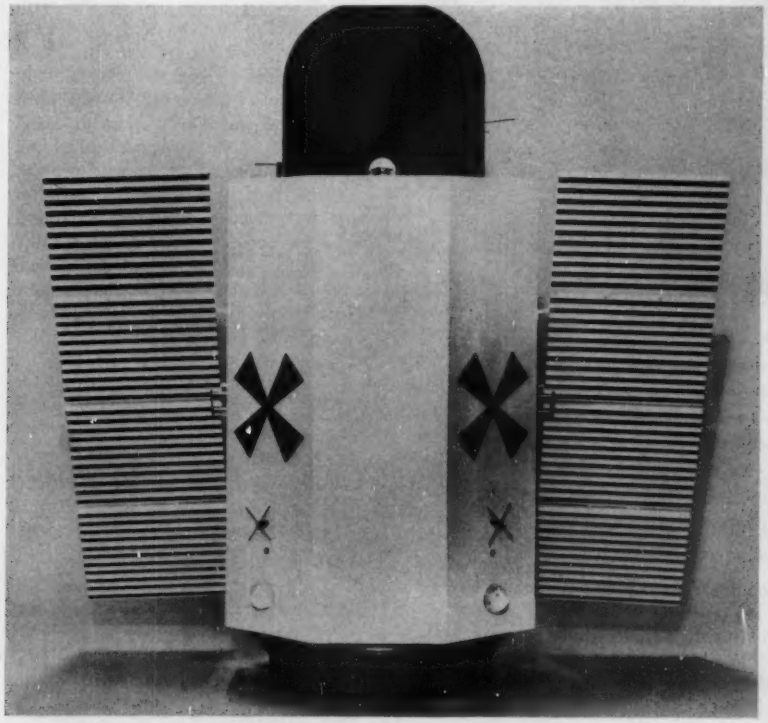


Reactor Fuse Snuffs Out Fission

Nine fuses will provide super safety in the Maritime Gas-Cooled Reactor Critical Experiment by automatically shutting down operations in case of "overload." Designed by Atomics International, division of North American Aviation Inc., the fuses are partly inserted in the reactor core (where atomic fission takes place). Completely self-contained in cylinders, fuses sense a power surge, trigger boron-trifluoride gas from the high-pressure area (left) to the inserted section (right). The gas rapidly absorbs neutrons, bringing the reactor under control.

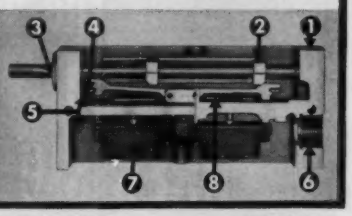


Astronomy: Over the Haze for a Better View

Designed to carry telescopic gear into orbit—where the view is unobscured by the earth's atmosphere—a new satellite being developed by NASA will thus eliminate a major problem in modern astronomy. Scheduled for launching in late 1963, the Orbiting Astronomical Observatory will carry reflecting mirrors up to 36 in. in diameter, coupled to a stabilizing system more accurate than that of any earthbound observatory. It will track a star with an accuracy of 0.1 second of arc, which is roughly the equivalent of focusing on a basketball 500 miles away. Designer of the OAO craft, Grumman Aircraft Engineering Corp., says the vehicle will be a standardized shell containing stabilization, power, and telemetry instruments, into which one or more separate experiments can be fitted for each flight. Solar-cell paddles will generate 350 watts of power needed for the equipment. The 3200-lb vehicle will be 9½ ft long and 6 ft in diam.

If you design or build automatic machinery . . .

PARAMOUNT LINEAR CONTROL
can save you much time and money



PATENTS PENDING — CUT-AWAY VIEW

Standard, heavy-duty unit with two switch elements for "limiting" applications.

Here's the "inside" story

Paramount's new LINEAR CONTROLS are now available in a variety of sizes for limiting, sequencing, monitoring, etc., applications. All heavy duty types built to conform with JIC Electrical Standards.

Paramount's LINEAR CONTROL is self-contained. Therefore, it reduces engineering, inventory, assembly, and wiring to absolute minimum.

1. **Gasketed Cover** completely encloses unit.
2. **Adjustable Cams** clamp to actuator tube.
3. **Self-Lubricating Bearing** and teflon seal.
4. **Reset Stop Screw** limits switch spring action for longest life.
5. **Two Compartment Construction** separates mechanical and electrical.
6. **Conduit Opening,** only one needed.
7. **Heavy-Duty** switch element.
8. **Diaphragm** and retainer around actuating pin oil proofs electrical compartment and aids resetting.

Save time and money designing and building automatic machinery with

PARAMOUNT LINEAR CONTROL

Paramount Textile Machinery Company
131 S. Wabash, Chicago 3, Illinois
4-810 Phone: Financial 6-0125

Circle 420 on Page 19

Giants of American instrument industry, including such firms as . . .

- Bulova Research & Development Laboratories, Inc.
- Eclipse Pioneer, Division of Bendix Aviation Corp.
- Federal Telecommunication Laboratories, Inc.
- General Electric Co.
- Sperry Gyroscope Co.

and many others think of CHATILLON, when instrument design calls for the "world's most accurate spring".

CHATILLON . . . the leading manufacturer of precision springs is particularly proud of the improved performance record of instruments using the noteworthy CHATILLON developed temperature-compensated alloy "Iso-Elastic". The hysteresis error of this remarkable spring is less than .05% of deflection. Drift does not exceed .02% of deflection in 5 minutes. These characteristics plus temperature compensation insure the ultimate in precision spring production.

CHATILLON makes Extension, Spiral, Torsion, Compression and Form Springs of Iso-Elastic material, as well as springs of all conventional alloys.

To find out how "the World's Most Accurate Spring" can better your product and for engineering bulletins, write CHATILLON SPRING DIVISION.

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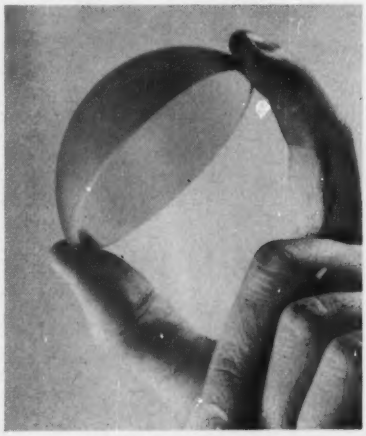
SPRING DIVISION
48 FRANKLIN ST., N. Y. 13, N. Y.
Manufacturers of Scales, Force Measuring Instruments and Precision Springs Since 1835

Hot-Pressed Lenses Extend Infrared Range



Heat-seeking re-entry vehicles will home-in, even at temperatures up to 1800 F, when lenses are made from new infrared transmitting materials. The Irtran series, developed by Eastman Kodak Co., Rochester, N. Y., can be hot-pressed into a variety of shapes up to a maximum of 6½ in. in diameter, and 3 in. in thickness. They are resistant to dust, acids, alkalis, organic solvents, and heat-cycling. The long-time temperature range of the material, the company states, is −330 F to 1500 F, and the range of optical properties of the materials makes them exceptionally useful in systems combining radar and infrared radiation.

Economics Push Soviet Welding

Lead Times Shortened On New Techniques

CAMBRIDGE, ENGLAND—Welding experts who visited Russia recently returned with the impression that the Russians are more concerned with getting new welding methods into the field than with fundamental research. The delay between development of a new method and the availability of equipment for industrial use is extremely short in the USSR.

The result, the British experts report, is that some unique and very economical construction techniques have been adopted that the West would do well to investigate. Many processes are improved under the pressure of economic factors differ-

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ent from those found in the free world.

Friction welding for instance, serves as an alternative to resistance flash welding, where power is in short supply. Components to be welded are mounted on a device similar to a lathe. Rotating and fixed pieces are brought into contact by hydraulic or pneumatic pressure, and the immense local heat generated is sufficient to weld the components. Although the method can only be used where one of the pieces is cylindrical, it is claimed that the rotary power supplied is far less than the power needed to supply heat through a transformer. The process is readily adaptable to mechanization.

Another economical method, also not well known in the West, is diffusion welding where clean surfaces to be joined are brought together in a vacuum and heat and pressure applied. Dissimilar materials may be readily joined by this process.

Meetings and Shows

Nov. 16-19—

Society of Naval Architects and Marine Engineers. Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Additional information can be obtained from society headquarters, 74 Trinity Place, New York 6, N. Y.

Nov. 20-22—

Fluid Controls Institute Inc. Fall Meeting to be held at The Drake, Chicago. Additional information is available from FCI executive secretary, E. R. Rath, P. O. Box 667, Pompano Beach, Fla.

Nov. 27-Dec. 2—

American Society of Mechanical Engineers. Winter Annual Meeting to be held at the Statler Hilton Hotel, New York. Further information can be obtained from Meetings Dept., ASME, 29 W. 39th St., New York, N. Y.

(*Please turn to Page 46*)

Design engineers note! RULON adds extra values to your products . . . low friction performance even without lubrication . . . wide temperature adaptability (−350° to +500° F) . . . high resistance to wear and deformation . . . and practically universal chemical inertness. Unlike nylon and many other materials, RULON won't swell in presence of moisture.

RULON is the sure relief to many a design headache. For RULON engineering Brochure #9572, write

DIXON CORPORATION
BRISTOL, RHODE ISLAND

Dixon Suppliers of basic shapes and fabricated parts in Rulon and Teflon

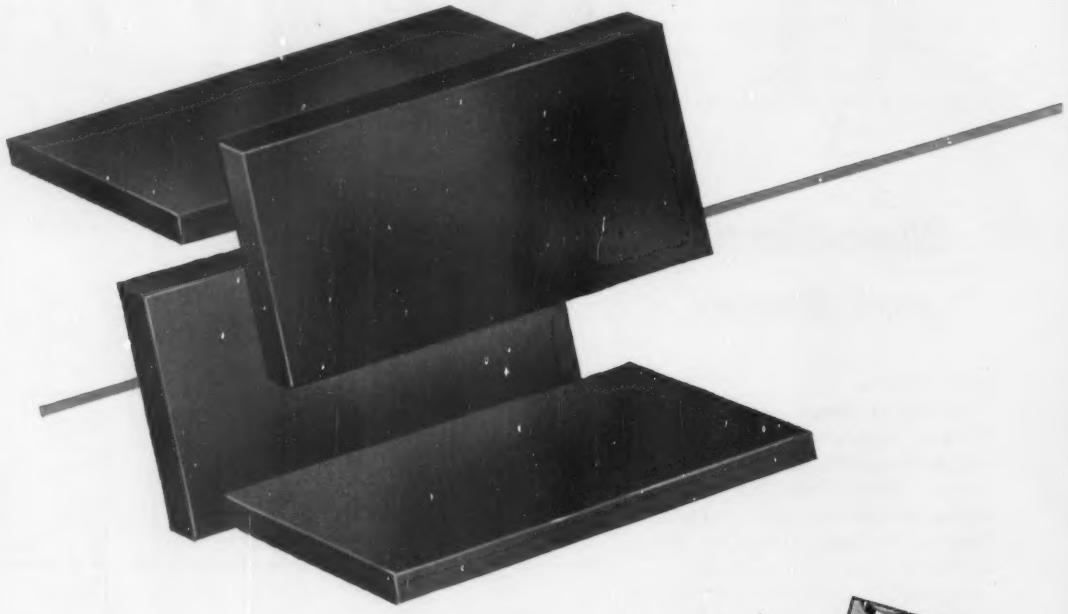
Circle 422 on Page 19

GRAPHITAR® VANES

(CARBON-GRAPHITE)

and long life of CONDE

This rotary positive displacement pump, engineered and produced by the Dri-Air Pump Department of the Conde Milking Machine Company, Inc., of Sherrill, N. Y., is designed to deliver clean, dry air or gas for high vacuum and low pressure applications in hospitals, dental offices, chemical or pharmaceutical plants, industrial processing systems and in metalworking plants. Thanks to vanes of GRAPHITAR, the CONDE Dri-Air Pump gives years of trouble-free, continuous operation at maximum recommended vacuum and speed . . . *without lubrication!* The GRAPHITAR pump vanes are self-lubricating and are seated by centrifugal force. Operating with a minimum of friction, they become increasingly efficient as the pump is used. In addition to their self-lubricating properties, the GRAPHITAR vanes are hard, light, non-sticking, non-warping and chemically inert. Perhaps these qualities can be utilized to advantage in your products.



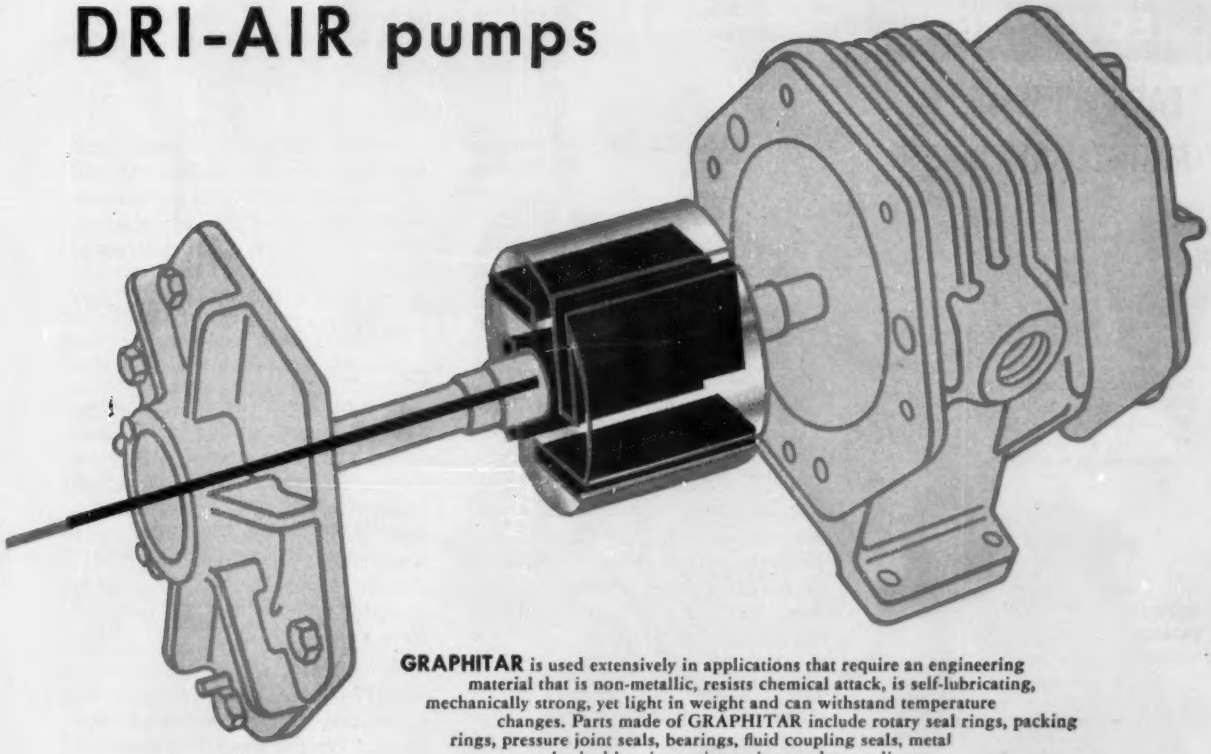
Bulletin #20 includes detailed design data along with properties, characteristics and typical applications of GRAPHITAR. Write for your free copy. If you have questions concerning the incorporation of GRAPHITAR parts in your products, our engineers will be glad to assist you.

THE UNITED STATES

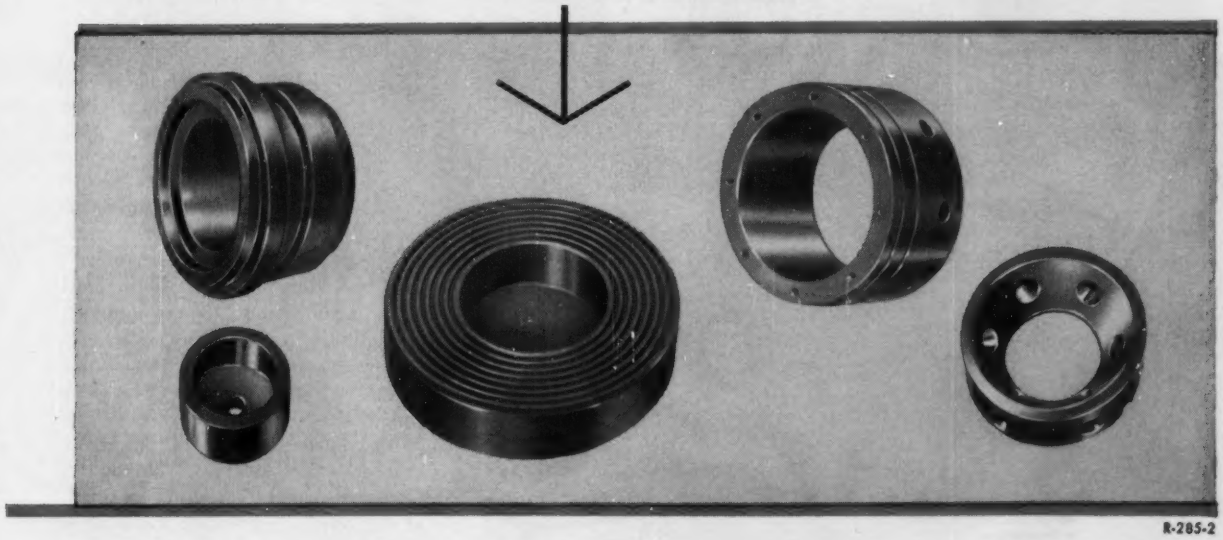
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

help insure efficiency

DRI-AIR pumps



GRAPHITAR is used extensively in applications that require an engineering material that is non-metallic, resists chemical attack, is self-lubricating, mechanically strong, yet light in weight and can withstand temperature changes. Parts made of GRAPHITAR include rotary seal rings, packing rings, pressure joint seals, bearings, fluid coupling seals, metal backed bearings, piston rings and pump liners.



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GRAPHITE COMPANY

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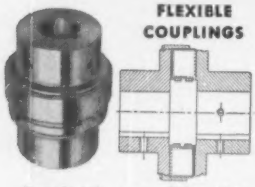
LOVEJOY
POWER TRANSMISSION EQUIPMENT

EASILY INSTALLED, MAINTENANCE-FREE

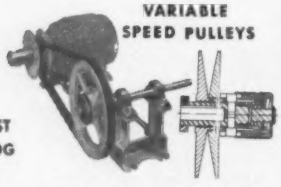
FLEXIBLE COUPLINGS



REQUEST CATALOG C-58

Bores (max.).....⅝" to 9½"
O.D. .....⅝" to 21½"
Wt. .....½ oz. to 1500 lb.
H.P. .....1/20 to 4250
Torque (static). 1½ to 5100 ft.-lbs.

VARIABLE SPEED PULLEYS



REQUEST CATALOG P-58

Bores (max.).....½" to 1⅝"
O.D. .....3" to 13⅜"
Belt Sizes.....A to 2¾ TW
Speed Ratios.....1-1 to 8-1
H.P. (1750 rpm.).....¼ to 15

UNIVERSAL JOINTS

REQUEST BULLETIN 820

Bores.....¼" to 2"
Hub Dia. .....½" to 4"
Static Torque 340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

VERSA-MOUNT TAKE UP FRAME

REQUEST BULLETIN V-647

For All Pillow Blocks—Ball, Roller or Babbitted
Mount Top, Side, Inverted or Reverse-foot
Sizes ....½" to 2-7/16" Blocks
Travel lengths ..... 2" to 36"

Write for above literature today.

LOVEJOY FLEXIBLE COUPLING CO.

4818 West Lake Street, Chicago 44, Illinois
Circle 424 on Page 19

(Continued from Page 43)

Nov. 28-Dec. 2—

Twenty-fourth National Exposition of Power and Mechanical Engineering to be held at the Coliseum, New York. Additional information is available from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Nov. 30-Dec. 2—

Futuronics Exposition, sponsored by the Long Island Electronics Manufacturers Council, to be held at Roosevelt Raceway Exhibit Hall, Westbury, Long Island, New York. Further information can be obtained from Rogers & Agate Inc., 19 W. 44th St., New York 36, N. Y.

Dec. 3-6—

Fourth Annual International Visual Communications Congress to be held at the Hotel Sherman, Chicago. Sponsors are the American Institute for Design and Drafting and the Society of Reproduction Engineers. Additional information is available from VCC headquarters, 10600 Puritan Ave., Detroit 38, Mich.

Dec. 5-8—

American Rocket Society. Annual Meeting and Astronautical Exposition to be held at the Shoreham Hotel, Washington, D. C. Further information can be obtained from society headquarters, 500 Fifth Ave., New York 36, New York.

"I knew something like this would happen as soon as a woman took over the job."

Dec. 5-8—

National Conference on the Application of Electrical Insulation to be held at the Conrad Hilton Hotel, Chicago. Sponsors are the American Institute of Electrical Engineers and the National Electrical Manufacturers Association. Further information can be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Dec. 12-15—

Atomic Industrial Forum and American Nuclear Society. Atomic industry exhibitions and conferences to be held at the California Masonic Memorial Temple, San Francisco. Further information can be obtained from AIF, 3 E. 54th St., New York 22, N. Y.

Dec. 13-15—

Eastern Joint Computer Conference to be held at the Hotel New Yorker and Manhattan Center, New York. Sponsors are Institute of Radio Engineers, American Institute of Electrical Engineers, and Association for Computing Machinery. Additional information is available from IRE, 1 E. 79th St., New York 21, N. Y.

Dec. 17—

Institute of the Aerospace Sciences. Wright Brothers Lecture to be given at the Natural History Bldg. Auditorium, Smithsonian Institution, Washington, D. C. Further information can be obtained from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 9-13—

Society of Automotive Engineers Inc. International Congress and Exposition of Automotive Engineering to be held at Cobo Hall, Detroit. Additional information is available from the society, 485 Lexington Ave., New York 17, N. Y.

Jan. 17-19—

Instrument Society of America. Winter Instrument - Automation Conference and Exhibit to be held at the Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis. Further information can be obtained from ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

Jan. 29-Feb. 3—

American Institute of Electrical

CUSTOM-MADE

Stainless Strip from Allegheny Ludlum

Stainless steel strip problems are solved at Allegheny Ludlum. Excellent forming characteristics, close gauge control, special analyses, color matching, and special finishes are only a few of the plusses A-L offers to solve your problems.

Here are some examples of A-L stainless strip made to solve individual problems:

- Type 430 with low roping quality.
- The economical 200 series . . . line free! And with increased ductility.
- Type 430 with a bright mirror finish, free of gray streaks.
- Type 302 with quality that enables a fabricator to form a coffee percolator in nine draws without an intervening anneal.

Your individual needs will get the attention you want them to have at Allegheny Ludlum. Tell your A-L representative the end use, fabrication procedures, etc., for your strip. He will work with A-L metallurgists, processing engineers, and technical men to give you the best stainless strip, custom made for your use.

Allegheny Ludlum service in stainless strip is backed up by an outstanding record for on-time delivery. Large stocks of hot bands enable A-L to give you quick service on all stainless strip needs. And A-L finished stocks give you quick, even overnight, delivery on many gauges and analyses.

For consistent temper, tolerances, and finish in stainless steel strip, call your Allegheny Ludlum salesman, or write: Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pennsylvania. Address Department MD-11.

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ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

all the advantages of Teflon* plus unique resistance to cold flow

If you can't keep bearings lubricated—if they operate in corrosive atmospheres, or in high or low ambient temperatures – RILOAD® bearings will work where nothing else will. Teflon's inherent low coefficient of friction remains the same from – 450° to 500° F., and it resists virtually any corrosive atmosphere.

RILOAD bearings are custom made with glass filled Teflon (increasing wear life 500 times) molded onto perforated metal. This unique design increases mechanical strength and gives high resistance to cold flow; PV values in the order of 20,000 have been applied. Riload Bearings are designed to dissipate heat efficiently and will operate in hot applications where other bearings fail.

RILOAD bearings are designed for press fit into the bearing housing with a custom fit to the shaft O.D. For full technical information on your particular application send design data to: Modern Industrial Plastics Division, P. O. Box 1019, Dayton, Ohio.

*Registered trademark of Dupont

Modern Industrial Plastics Div.
Dayton, Ohio

DURCO

Engineers. Winter General Meeting to be held at the Hotel Statler, New York. Further information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Short Courses and Symposia

Dec. 7—

Seminar on Electrohydraulic Servo Systems, sponsored by the Milwaukee School of Engineering and the Milwaukee Chapter of the Fluid Power Society, to be held at the school. Further information is available from Mel Streigel, Milwaukee School of Engineering, Technology Park, Milwaukee 1, Wis.

Jan. 9-11—

Seventh National Symposium on Reliability and Quality Control to be held at the Bellevue-Stratford Hotel, Philadelphia. Sponsors are the Institute of Radio Engineers, American Institute of Electrical Engineers, American Society for Quality Control, and Electronic Industries Association. Additional information can be obtained from James H. Goodman, Radio Corp. of America, Bldg. 1-2, Camden 2, N. J.

Jan. 17-18—

Bearing Symposium, dealing with design and lubrication of bearings in heavy industry, to be held at the Penn Sheraton Hotel, Pittsburgh. Sponsor is the American Society of Lubrication Engineers, 84 E. Randolph St., Chicago 1, Ill.

Jan. 23-Feb. 2—

Engineering and Management Course to be held at UCLA. Participants select four classes from a group of 22, including such subjects as reliability for modern industry, industrial psychology, engineering and research administration, and effective managerial communication. Public speaking classes are also offered. Further information can be obtained from Reno R. Cole, Co-ordinator, The Engineering and Management Course, College of Engineering, University of California, Los Angeles 24, Calif.

CAPABILITY
is spelled
a-u-x-i-l-i-a-r-y
p-o-w-e-r

In technology and facility, Vickers continually matches your need

Experience gained on every type of military aircraft and commercial airliner plus numerous missile applications assures top performance from every Vickers auxiliary power package. Either complete and separate power generating systems or motorpumps can be provided depending on specific application requirements.

Precise performance evaluation—particularly on motorpumps—can often be provided even before the final package is developed from proved standard elements by building up prototype units and subjecting them to feasibility and performance tests. From these prototypes come the ultimate custom designed packages providing a high order of reliability and requiring minimum input power—all in a compact, lightweight envelope.

Additional data is available in two new Vickers bulletins: A-5239 "Power Systems" and A-5258 "Motorpumps". Write for your copies to either address listed below.

All components of Vickers auxiliary power units are subjected to thorough inspection by skilled technicians following evaluation tests. New size of standard element is shown being inspected following 40,000 rpm cycle test.

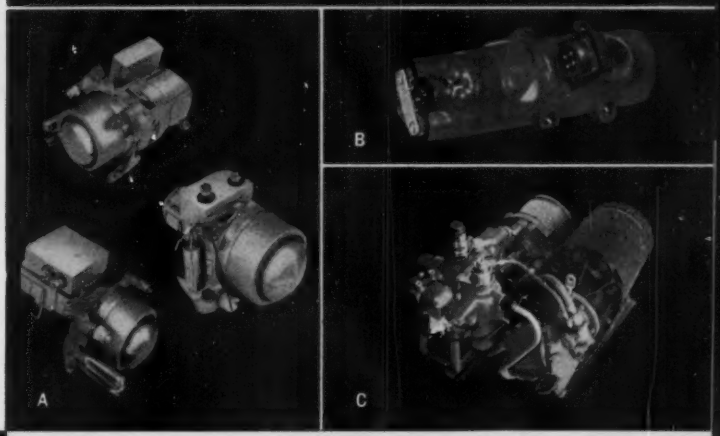
A. Integrated motorpump for one of newest IRBM missiles.

B. Battery-powered motorpumps developed for each stage of an ICBM missile.

C. Integrated AC motor-hydraulic power supply for intercontinental bomber turret drive.

Final testing, evaluation and assembly is performed in a special, surgically clean room. Thus, once parts are super-cleaned, no additional contamination is introduced.

TYPICAL AUXILIARY POWER PACKAGES DEVELOPED BY VICKERS:



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AERO HYDRAULICS DIVISION
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POWER TRANSMISSION
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FLUID TRANSFER

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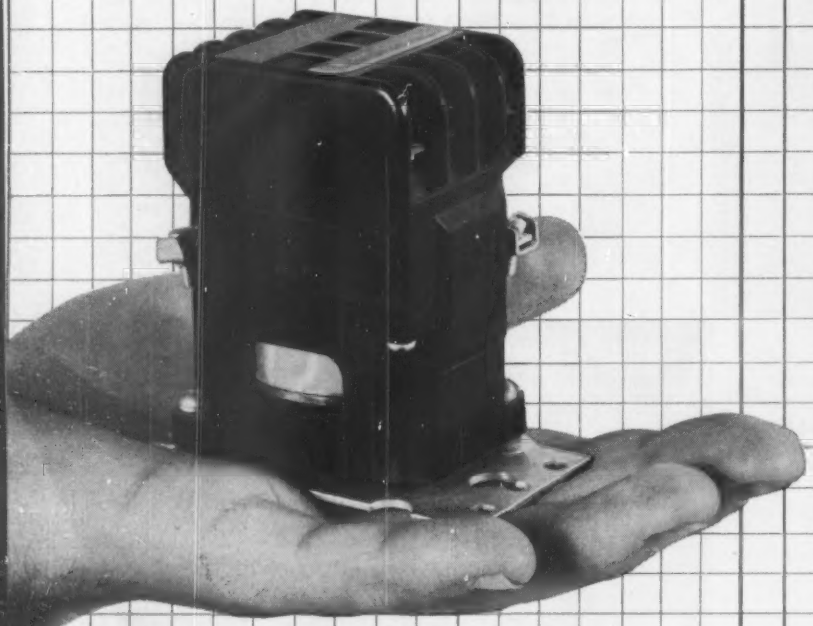
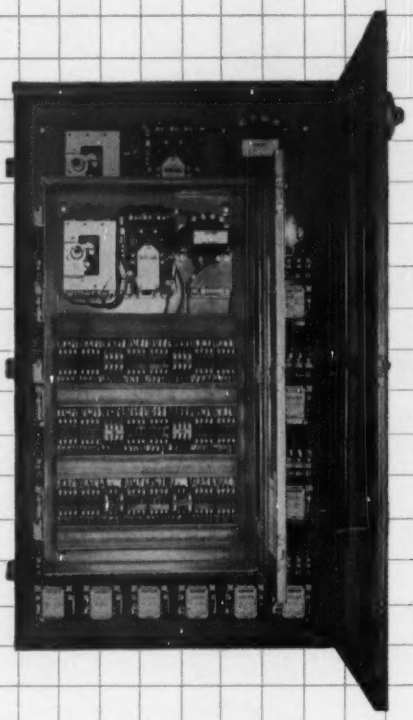
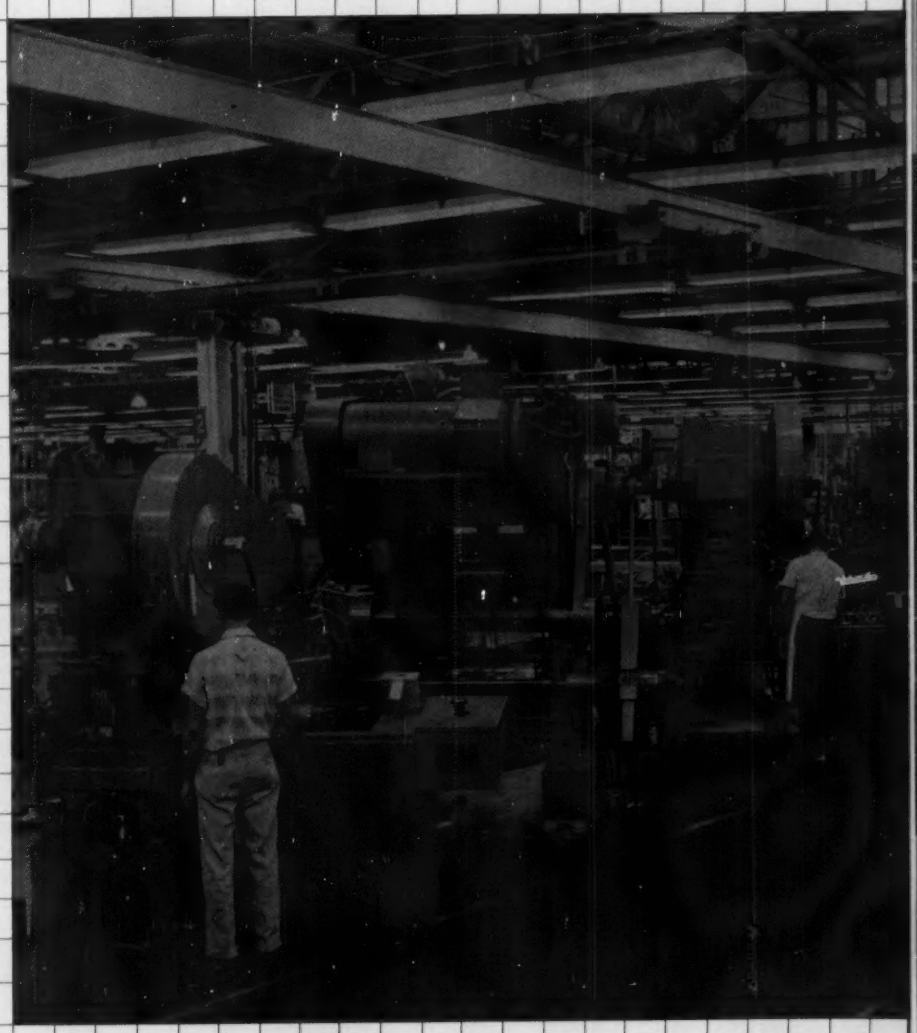


This new Westinghouse BF relay . . .



saves inches here . . .

This new Westinghouse BF relay is small and can be butted one against the other so that your control panels can be reduced in size as much as 50%. Result: valuable plant floor space available for additional machines. Because the relay is specifically designed for automated machine tools, you cut installed costs more than 20%. And since this relay is in stock, you get these savings NOW.



feet here . . .

Want more information on the 6-amp, 300-volt BF and its companion, the 10-amp, 600-volt AF? Contact your nearest Westinghouse representative . . . or write Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. J-30321-R

You can be sure...if it's **Westinghouse**

Circle 428 on Page 19

"Not one failure in 10 years with USS American springs"

Mr. Lee Dunn, Sales Manager of Walter Balfour & Co., Inc., tells why American Steel & Wire Springs are used in Balfour Doc-Port Rolling Steel Pier doors.

"The springs in our doors have to be exceptionally tough and dependable," says Mr. Dunn. "The performance of the doors is dependent upon the quality of the springs. The springs must act uniformly over their entire length because the doors must be perfectly counter-balanced at every point of travel. Springs of the same wire diameter and coil diameter *must* have identical characteristics. In the ten years we've been using American Steel & Wire springs, we've never experienced a failure.

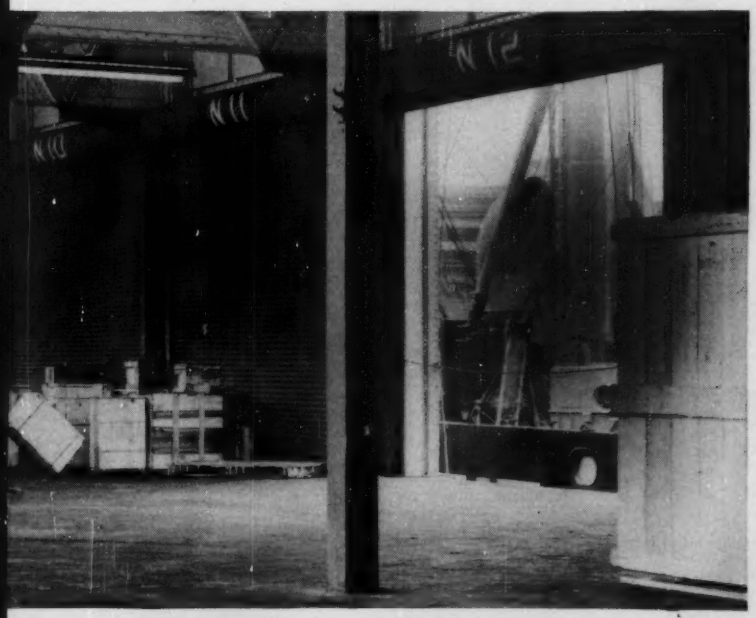
"Most of the USS American springs used by the Balfour Company are made from 5/16" cold wound wire. In the larger steel pier doors there are actually multiples of our helical torsion spring sizes . . . 3/8", 5/16", 1/2", and 13/32". Springs are nested one within another, each spring mounted on shaped cast anchors which are fixed to a single torsion rod, so that the springs are equally and simultaneously loaded."

When springs are your special problem, come to American Steel & Wire. Our Spring Engineering Service has a solid reputation for coming up with the right answer at the right time. They'll be glad to pitch in on your problem. Give us a call today, or write American Steel & Wire, Dept. 0402, 614 Superior Avenue, N.W., Cleveland 13, Ohio.

USS and American are registered trademarks

Cold wound springs in Balfour doors are placed inside steel cylinders and fixed on each end to anchors that prevent internal collapsing of the springs at contact points.

Balfour doors are exposed to heavy wind loads and salt water spray, but they can take it—and so can the USS American springs.



3000 lbs. ride on each USS American spring assembly every time these big 18′ x 24′ Balfour Pier doors open and close. It takes rugged, long-lasting springs to stand up under this kind of punishment.

American Steel & Wire
Division of
United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
Tennessee Coal & Iron Division, Fairfield, Alabama, Southern Distributors
United States Steel Export Company, Distributors Abroad

This mark tells you a product is made of modern, dependable Steel.

Circle 429 on Page 19

This is IMAGINEERING...

Window mechanism by Tilt-O-Pane Distributing Corporation, Pittsburgh, Pennsylvania

Saved: 80% in raw materials alone!

We changed the design . . . a little. But, the big change was *how to make* this special T-head bolt for Tilt-O-Pane, the window with the hidden hinge.

Previously machined *from solid bar stock*, 80% of the bar became chips . . . scrap on the machine shop floor . . . and the shank and head often parted company during installation.

Screw and Bolt design engineers were able to "impact-form" this special bolt for Tilt-O-Pane from less expensive wire stock. (*other bolt makers said it couldn't be done*)

Result:

- substantial cost reduction effected
- raw material loss eliminated
- strength problem totally corrected
- window hinge reliability considerably improved
- product assembly simplified

and Screw and Bolt's *imagineering* cost nothing!

Imagination, coupled with engineering, can do the same for you. If you don't know where you can use Screw and Bolt's *imagineering*, it's already costing you money!

VMA 7619

SCREW AND BOLT CORPORATION OF AMERICA

SERVES THE NATION

P. O. Box 1708 • Pittsburgh 30, Pennsylvania

DIVISIONS: Pittsburgh • Gary • Southington Hardware • American Equipment

AMERICA'S MOST COMPLETE LINE OF INDUSTRIAL FASTENERS

Handsome and Hardworking

Plexiglas...Implex

for Jet Spray Cooler . . . PLEXIGLAS® acrylic plastic is used for sparkling transparent bowls and lids on cold drink dispensers. Bowls and lids are one-piece moldings—crystal clear, breakage-resistant and free from taste or odor. Seven-inch-deep bowls measure 17" by 14".

for Smith-Corona . . . IMPLEX®, the tough, rigid, high-impact acrylic, gives outstanding strength and stain-resistance to vital components of new Galaxie portable typewriters. In addition, the smooth surfaces and lustrous colors of the IMPLEX parts contribute to the typewriter's handsome appearance.

for you . . . PLEXIGLAS and IMPLEX can give your products added utility and sales appeal. Our design staff will be pleased to help you use these Rohm & Haas molding materials—to your advantage.

Chemicals for Industry

ROHM & HAAS COMPANY

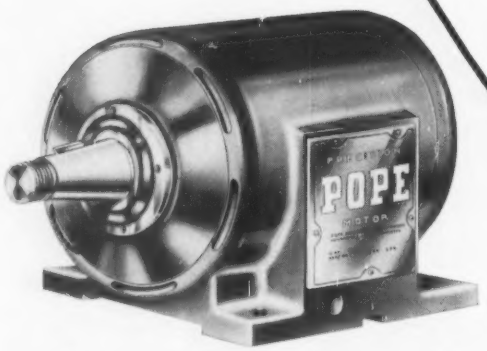
WASHINGTON SQUARE, PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Co. of Canada, Ltd., West Hill, Ontario*

Circle 432 on Page 19

WANTED

a real PRECISION motor twenty five millionths (.000025) vibration amplitude maximum shaft runout— 75 millionths (.000075)



Now it's here . . .

THE POPE PRECISION Totally Enclosed Fan Cooled Custom-Built MOTOR

1 to 20 H.P.—900 to 3600 R.P.M.—with straight or tapered shafts

Here is a Precision Driving Motor that has the rigidity and dynamic balance you've always wanted!

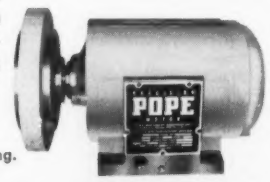
The permanently preloaded double row cylindrical roller bearings with tapered bores are mounted in a heavy section one-piece casting. (There is no front end cover to get out of alignment.)

A pair of extra large precision angular contact preloaded bearings in the rear housing are mounted close to the rotor for extra rigid support of the motor under working loads.

You can make fast convenient wiring connections from the large junction box furnished on whichever side of the motor you specify.

Ask for data sheet SK-306 for outline dimensions and specifications.

Let us quote you on these Precision Driving Motors for use on all your equipment where a real Precision Motor is required.



One of the new Pope Precision Motors equipped with a Pope balancing type wheel holder for precision grinding.

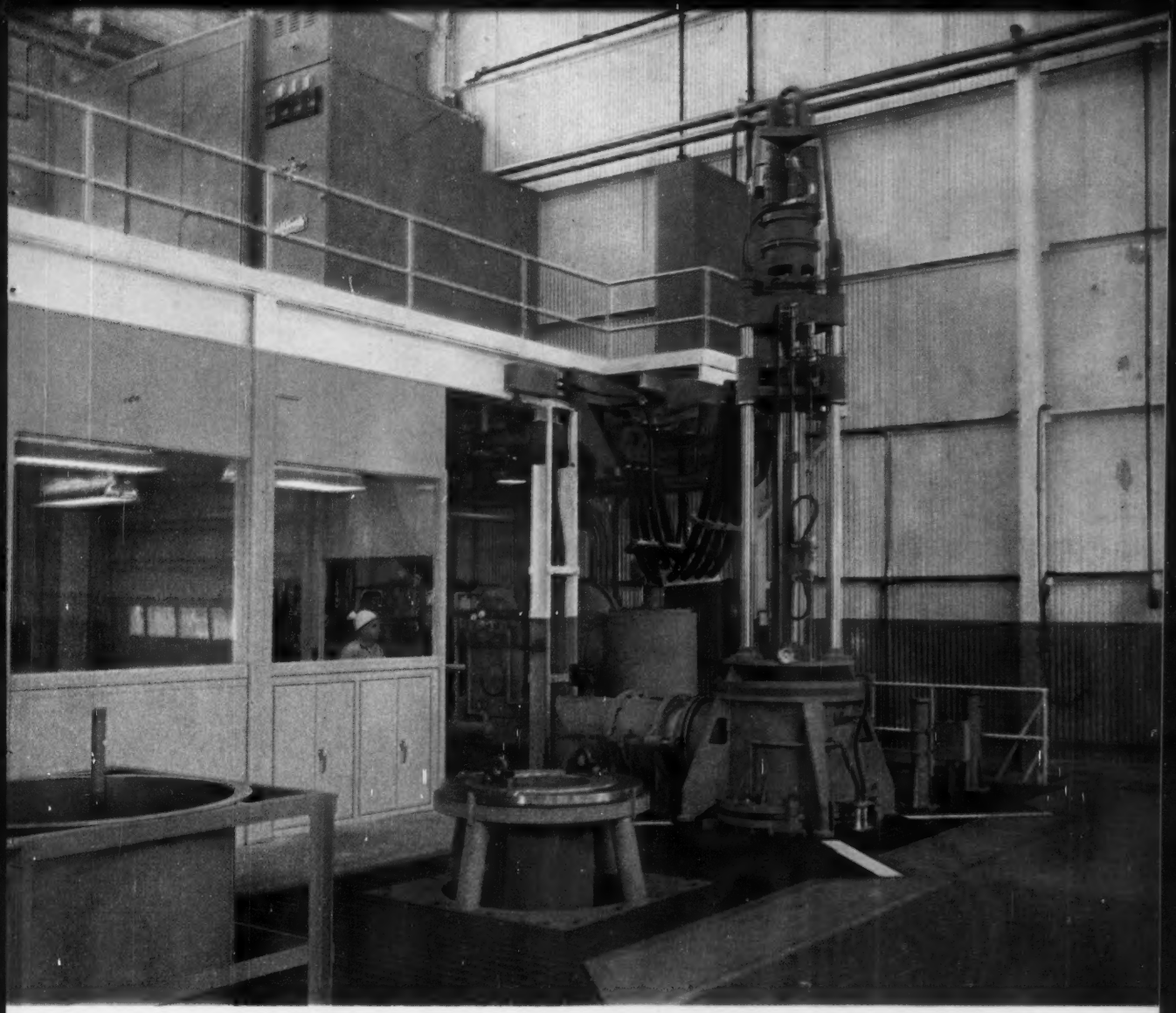
No. 130

POPE®

ENGINEERS, DESIGNS AND BUILDS PRECISION ANTI-FRICTION BEARING SPINDLES FOR EVERY PURPOSE

POPE MACHINERY CORPORATION • 261 RIVER STREET • HAVERHILL, MASS.

Established 1920



SPECIAL QUALITY STEELS AVAILABLE AT STANDARD

One of the largest vacuum arc remelt furnaces in the country—the first of four to be installed—is now in operation at Standard Steel Works Division of Baldwin-Lima-Hamilton Corp. This new facility, together with electric melting furnace and vacuum degassing equipment acquired recently, now makes it possible for Standard to deliver "laboratory-quality" steels in production quantity.

Standard is now capable of producing vacuum remelt quality ingots, up to 30-inch diameter, in all of the super-strength steels and special alloys requiring exceptional quality. Standard continues to offer superior service and superior materials to American industry. We especially welcome forging and ring inquiries for tools, missiles, turbines, bearings and similar applications for super-strength, heat-resistant, corrosion-resistant and other special alloys.

Standard Steel Works Division
BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes

Circle 434 on Page 19

V-R Metals...

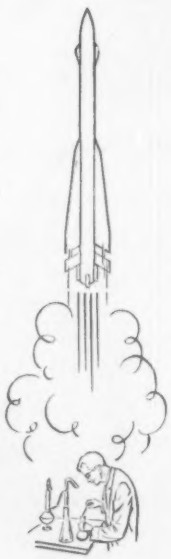
when CORROSION strikes...

Metals of tomorrow ...TODAY!

Vascoloy-Ramet, pioneering manufacturer of refractory metals, is making a substantial contribution to today's advancing metallic age. V-R is creating and developing special metals with exceptional characteristics to meet the ever-changing demands of industry. Thirty years of V-R research, engineering, and manufacturing experience have produced the metallurgical knowledge built into all V-R products. This same experience and knowledge is working full time to meet the needs of tomorrow.

A-798

V-R



Vascoloy-Ramet creates metals that are impervious to corrosion. V-R also creates metals that possess amazing stability at extreme temperatures, high rigidity under load, extremely low coefficients of expansion, ultra-high density and controlled uniformity.

Yes, many of today's metal requirements are met by Vascoloy-Ramet. V-R designs these sintered and alloyed materials to fill your metal requirements. Many engineers are utilizing V-R assistance for metal design assurance.

For additional information, contact V-R today.

CREATING THE METALS THAT SHAPE THE FUTURE

VASCOLOY-RAMET

858 MARKET STREET • WAUKEGAN, ILLINOIS

Circle 435 on Page 19

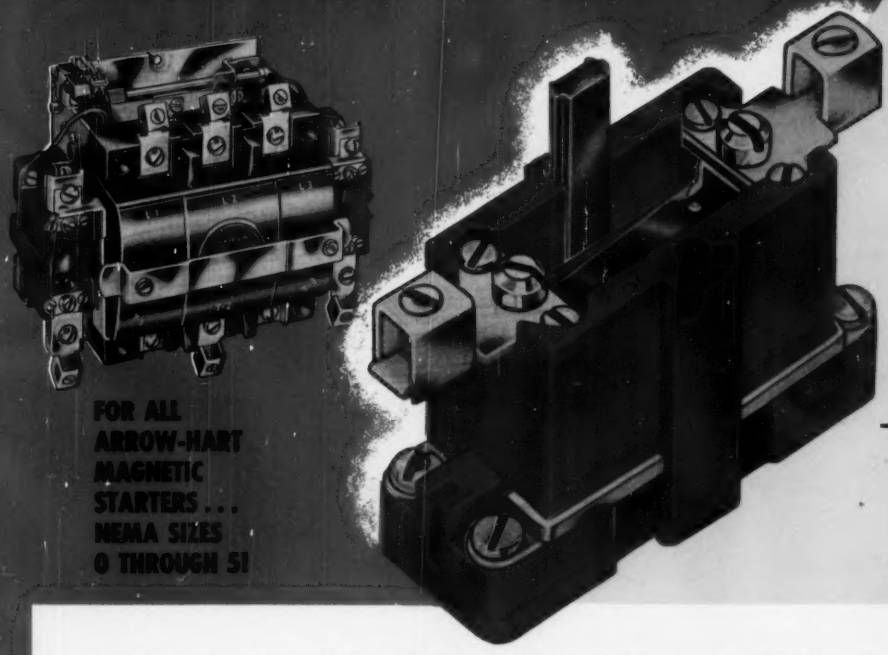
Circle 436 on Page 19→

ANNOUNCING

Something NEW under the sun

the ARROW AH HART

AMBIENT COMPENSATED OVERLOAD RELAY



FOR ALL ARROW-HART MAGNETIC STARTERS . . . NEMA SIZES 0 THROUGH 5!

RELIABLE AND ACCURATE PROTECTION REGARDLESS OF HEAT OR COLD

Here, for the first time, is a compact overload relay that compensates for both heat and cold, operating on the same time curve at all temperatures from -20° F to 165° F. Compensation is completely automatic. No field adjustment is needed. Operating mechanism is simple, rugged and dependable.

This performance is made possible by the exclusive Arrow-Hart "Balancing Bi-Metal" which is located in a separate compartment and is not; therefore, affected by heat applied to the working bi-metal.

- **MUCH SMALLER SIZE** . . . than any other comparable unit now available. Base size is the same as standard A-H Overload Relays.
- **USES STANDARD HEATERS** . . . and works equally well with either quick-trip or regular type.
- **COMPENSATES AUTOMATICALLY** for both heat or cold, by means of an exclusive, "Balancing Bi-Metal" Effective through a temperature range from —20° F to 165° F.
- **DEPENDABLE IN OPERATION** . . . and requires no adjustments of any kind.
- **AVAILABLE** . . . with all A-H Starters. Ratings from 25 to 300 amperes, continuous current. Normally supplied with manual reset. If desired, relays can be equipped with a change-over lever that provides manual or automatic reset, as required.

IDEAL FOR USE . . .

OUTDOORS . . . in oil fields and other installations subjected to wide seasonal or daily changes in ambient temperatures.

INDOORS . . . for control installations located near boilers, furnaces, heating units or refrigeration equipment and subjected to wide daily changes in ambient temperature.

SEE NEXT PAGE FOR CONSTRUCTION DETAILS and ADDITIONAL DATA · · ·

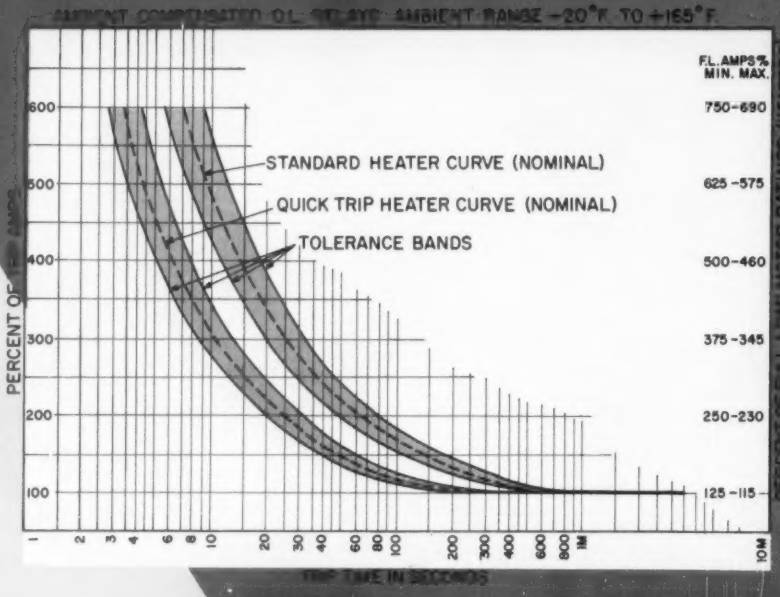
THE ARROW-HART & HEGEMAN ELECTRIC CO., HARTFORD 6, CONNECTICUT

AMBIENT COMPENSATED OVERLOAD RELAYS

WITH "BALANCING BI-METAL"

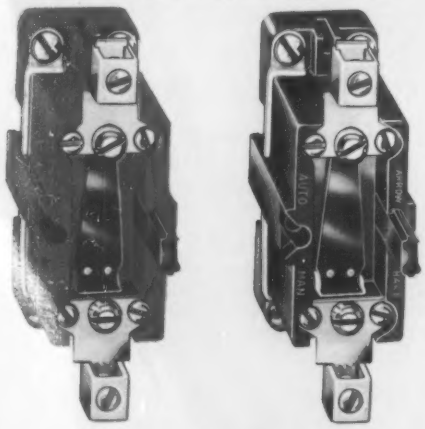
DEPENDABLE, AUTOMATIC COMPENSATION for A WIDE RANGE OF TEMPERATURE CHANGES

As shown in the accompanying drawing, the working bi-metal and the compensating bi-metal are identical in size and construction and are joined by a coupling bar. As the ambient temperature rises above 72°F, the compensating bi-metal operates through the coupling bar to move the working bi-metal in order to maintain its distance from the trip arm. Similarly, as the ambient temperature falls below 72°F, the compensating bi-metal operates to maintain its distance from the trip arm. Therefore, tripping time remains the same regardless of temperature. Switching mechanism itself employs the same positive snap-action featured in all Arrow-Hart Overload Relays. The calibrating screw permits precise setting. This screw is set and sealed at the factory and requires no further adjustment.

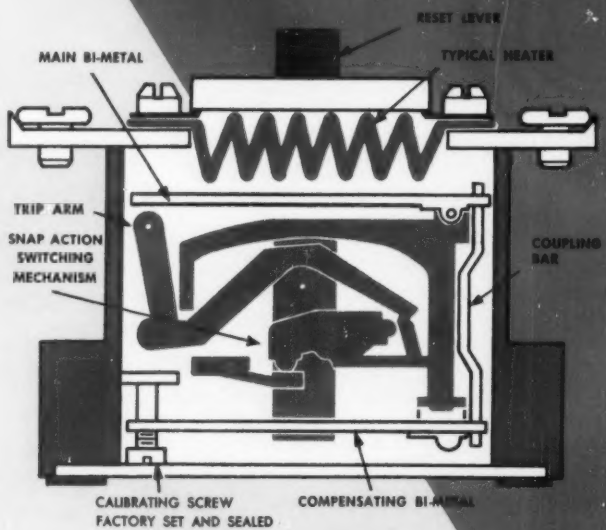


SEND NOW FOR COMPLETE INFORMATION

COMPARABLE IN SIZE TO STANDARD ARROW-HART O.L. RELAYS



New Ambient Compensated O.L. Relay — **Standard O.L. Relay**



PATENT NO. 2,908,786

OPERATES ON THE SAME TIME CURVE AT ALL TEMPERATURES FROM —20° F TO 165° F!

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 Hawthorn Street, Hartford 6, Connecticut
MOTOR CONTROL DIVISION

Please send me complete information on the new Arrow-Hart Ambient Compensated Overload Relays with exclusive "Balancing Bi-Metal" Mechanism.

name _____
position _____
company _____
co. address _____
city _____ zone _____ state _____

MD

ARROW AH HART

Quality since 1890

MOTOR CONTROLS • ENCLOSED SWITCHES
APPLIANCE SWITCHES • WIRING DEVICES

ELECTRONICS.... HYDRAULICS.... HEAT TRANSFER.... LUBRICATION

NUCLEONICS.... SONICS.... COOLANTS.... DIELECTRICS:

Monsanto Specialized Fluids and new FluiDesign Service can help you benefit from

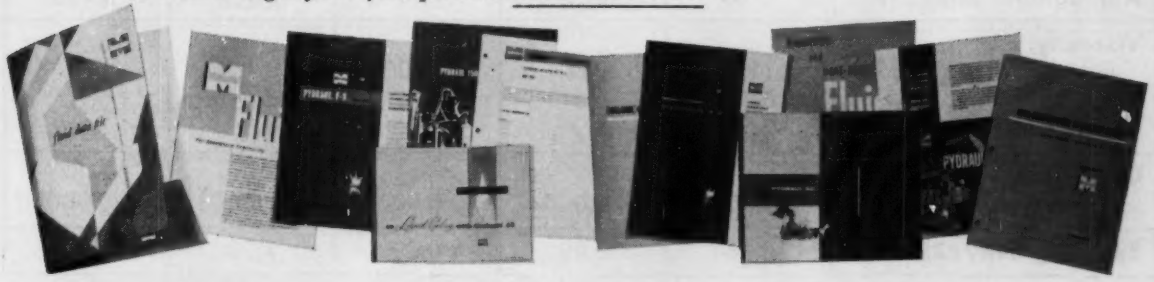
A RENAISSANCE IN ENGINEERING DESIGNS

Conventional fluids (water, oil) impose well-known restrictions on engineering designs. Heat, radiation, fire hazard, shear, electrical requirements, extreme pressure, friction—all cause problems—limit you in design flexibility, in imaginative thinking, in new ideas.

Monsanto's specialized synthetic fluids—chemically tailored to minimize many design restrictions in power transmission, lubrication, heat transfer, insulation, cooling—make new and improved designs practical. Spawned by advances in specialized fluid properties and broadening of fluid functions—a renaissance in engineering concepts is starting now. These specialized fluids open new design opportunities for your exploration.

Monsanto's new FluiDesign Service—established to help you meet your needs best from the capabilities of some thirty specialized fluids—can give you valuable guidance at the outset of your design exploration and engineering planning. For example, the next two pages provide you with the FluiDesign Service Report, "Heat-Stable Fluids for *Critical* Thermal Conditions." Among the thermally stable and radiation-resistant fluids described, one or more may allow you to engineer your next design for unequaled efficiency.

Be sure to get your fact-packed Fluid Data File...



Circle 437 on Page 19

From Monsanto FluiDesign Service . . .

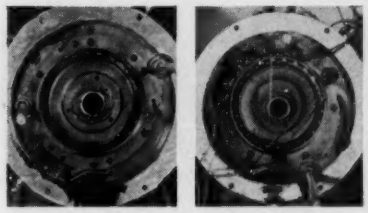
HEAT-STABLE FLUIDS FOR CRITICAL THERMAL CONDITIONS

Rapid evaporation, variable viscosity, foaming, cavitation, and "gunking up" at high temperatures are shortcomings of many common functional fluids. They are symptoms of thermal instability that bedevils operation of equipment.

Monsanto has developed a whole series of heat-stable synthetic fluids that eliminate many restrictions on new equipment design—*for applications that demand optimum thermal stability.* These chemically synthesized fluids include silicate esters, chlorinated polyphenyls, polyphenyls, and polyphenyl ethers. Some perform at freezing temperatures below *minus* 65° F. Others withstand continuous scorching heat above 800° F. Many are fire-resistant, radiation-resistant, noncorrosive. They give long, low-maintenance service as heat transferants, as lubricants, as hydraulic fluids, as dielectrics in high-temperature applications.

Monsanto Fluid	OS-59	Coolanol 35	Coolanol 45	Aroclor 1221	Aroclor 1232	
Properties						
Max. bulk temp., °F. long term	500	400	400	600	600	
Radiation resistant . . .	No	No	No	No	No	
Thermal conductivity Btu/hr./ft.²/ft./°F. . .	0.077	0.079	0.080	0.067	0.063	
Specific heat, @ 25°C.. .	0.45	0.45	0.45	0.33	0.31	
Boiling point, °F. @ 760 mm. Hg	>700	>600	>700	527	554	
Flash point, °F. Cleveland Open Cup .	370	370	370	295	308	
Fire point, °F. Cleveland Open Cup .	435	430	430	349	460	
Auto-ignition temp., °F. .	. . .	655	700	>1000	>1100	
Viscosity, cs. @ −65°F.	1380	934	2400	. . .	. . .	
@ 100°F.	6.8	6.5	12.2	4.6	6.9	
@ 210°F.	2.2	2.2	3.95	<1.8	<1.8	
Coefficient of thermal expansion, per °F. . .	0.00046	0.00047	0.00048	0.00039	0.00040	
Specific gravity @25°/25°C.	0.88	0.89	0.89	1.18	1.26	

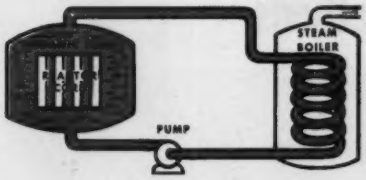
Monsanto offers a family of unique new fluids—*polyphenyl ethers*—that outperform all other known lubricants and hydraulic fluids in high-temperature operations. Their *useful* temperature range exceeds other thermally stable fluids by 100° to 400° F. The polyphenyl ethers not only match the lubricity and viscosity indices of other good lubricants, but also possess superior hydrolytic stability.



Photos courtesy of Pratt & Whitney Aircraft

Test rig parts for evaluating properties of jet engine lubricants show how a polyphenyl ether (left) leaves the rig parts clean, free of deposits, and with no evidence of wear. Photo at right shows deposits and general condition of parts using one of the best synthetic lubricants available prior to development of polyphenyl ethers. Both tests were run at a bearing temperature of 500° F. for 100 hours at a speed of 10,000 rpm.

Some Monsanto fluids are so radiation-resistant and thermally stable that they are used in the torturous environment of the nuclear reactor. Under an A.E.C. contract to develop low-cost electricity from nuclear power, Atomics International designed and built an experimental reactor at Arco, Idaho . . . using Monsanto terphenyl compounds as the coolant-moderator and heat-transfer agent. Nearly three



years of testing indicate that these stable Monsanto fluids can successfully and economically transfer the tremendous heat of the "nuclear furnace" to steam generators.

Check the fluids described below for application in equipment you are using or developing. Monsanto can supply you with a thermally stable fluid to solve virtually any critical problem of high heat or radiation. By advance planning with Monsanto FluiDesign Service, it is possible to "chemically tailor" a stable synthetic fluid to your precise needs.

Samples of the fluids shown will be sent to you for evaluation on request. Please specify the particular fluid that interests you and state the nature of the application, so that pertinent details can be sent to you. For further information on available fluids, request a copy of FluiDesign Service's FLUID DATA FILE. Simply write on your company letterhead.

HB-40, Aroclor, Coolanol, Santowax: Monsanto T.M.s, Reg. U. S. Pat. Off.

Monsanto

Monsanto Chemical Company
Organic Chemicals Division
FluiDesign Service, Dept. 2765-A
St. Louis 66, Missouri

	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	OS-124 (polyphenyl ether)	HB-40	Santowax R
	600	600	600	600	800	800	> 750
	No	No	No	No	Yes	Yes	Yes
	0.058	0.057	0.054	0.051	0.077	0.072	0.063
	0.29	0.27	0.26	0.26	0.34	0.45	0.50
	617	644	689	725	982	683	687
	360	379	None	None	550	345	375
	> 610	> 640	> 662	> 698	660	385	460
	> 1200	> 1200	> 1200	> 1200	1135	> 1000	> 1000
	. . . 17.2 2.5	. . . 45.3 3.2	. . . 46.4 6.14	 75	. . . 363 13.2	. . . 29 3.9	. . . .
	0.00038	0.00039	0.00037	0.00037	0.00033	0.00041	0.00052
	1.38	1.45	1.54	1.62	1.204	1.002	0.955

Circle 437 on Page 19

Veeder-Root READOUT Bulletin

One of a Series

Predetermining Counters provide simplified methods for Automatic Control

Veeder-Root Predetermining Counters now make it possible to design and build automatic control into equipment of all types. They are available for mechanical, electrical and electronic control and offer many features and options to give your equipment extra value and versatility.

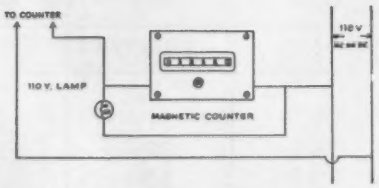
Predetermining Mechanical Counters can be applied to rotary, eccentric or stroke type motion, registering or counting whatever units are required — such as revolutions, motions, turns, pieces, lengths, and strokes. The newer electric and electronic Predetermining Counters use a special high speed light source and photo cell for non-contact counting on any machine or process.

Automatic control is provided by the predetermining counter actuating such devices as: lights, bells, signals and stop motions. They work at speeds up to 8000 counts per minute, can be easily incorporated into machine design and control panels. Application assistance is available from a Veeder-Root Counting Engineer; and specialized designs and modifications can be supplied in most cases. For complete information, call or write your nearest Veeder-Root office.

The High Speed Predetermining Counter is the basic counter in this complete line. It provides automatic control by this simplified method: . . . to set a run of 5451 pieces on the counter: (1) Set all white wheels to zero with one turn of wing-nut; (2) Now, set the metal wheels, one by one. Set first wheel to "5", opposite zero on its "opposite number" white wheel, then set the "4", "5" and "1" and that's all . . . you're ready to throw the switch and start the run.

High Speed, Quick Reset Predetermining Counters for electrical and mechanical control, at speeds to 8000 cpm.

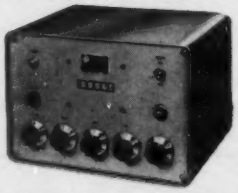
This counter has one set of wheels which are preset to any figure within the capacity of the counter by depressing the reset lever, raising the cover, and turning. The counter subtracts from the preset number to "00000", when a knock-off lever actuates an electrical switch. To reset, just press the reset lever, and counter returns instantly to preset figure. For Mechanical Control, counter actuates a mechanical lever instead of electrical switch. Speeds: 6000 rpm or 8000 counts per minute.



Addition of Magnetic Counter Provides Record of Total Lots.

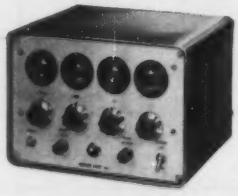
A Veeder-Root Magnetic Counter connected in series with the alarm or stop motion registers one unit for each of the predetermined lots produced. Provides a simple means to obtain both machine control and production control.

Electric Predetermining Counter Ideal for Batching, Length Measurment and Materials Handling.



This new counter offers automatic reset plus other important features: **1.** Instant automatic reset . . . Control contacts operate and hold for 0.3 seconds . . . or for 2 seconds . . . or indefinitely. **2.** Counter can be modified for automatic sequential predetermining, using two or more preset numbers. **3.** A batch or totalizing counter can be added. This counter is adaptable to material handling applications, slow speed batch counting, length measurement, slitting, and similar applications. Speeds up to 1000 cpm.

High Speed Electronic Predetermining Counters Feature Automatic Reset, 5000 cps.



The No. 1604 features instantaneous recycling. Up to six decade counters, with one, two, or more sets of preset numbers . . . with or without photohead or enclosure. Output relay provides momentary or indefinite holding time. Batch totalizing available. Ideal for all high speed counting, up to 5000 cps, recycle at 1000 cps.

Send for Literature and Technical Data . . . Extensive information and specifications on how to use Veeder-Root Predetermining Counters are yours for the asking. Send today.

Veeder-Root

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"The Name that Counts"

New York • Chicago • Los Angeles • San Francisco • Seattle
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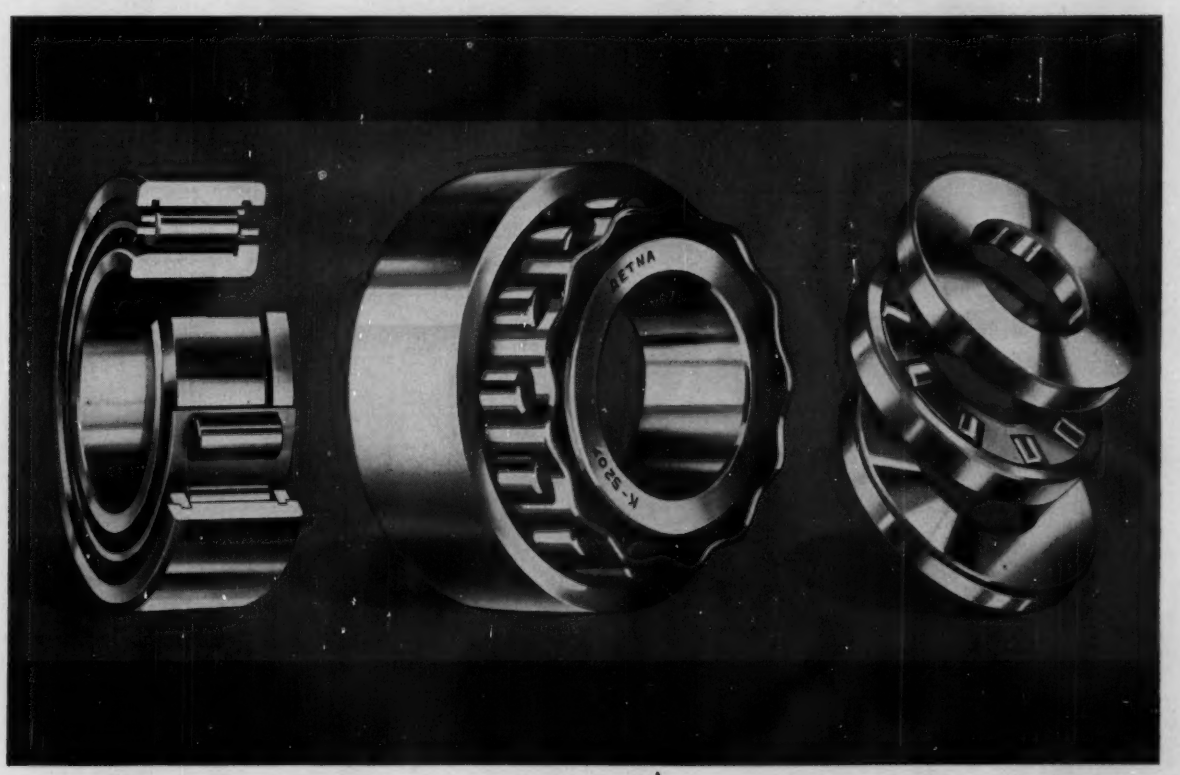
Aetna
ROLLER BEARINGS

What would you pay for greater bearing efficiency?

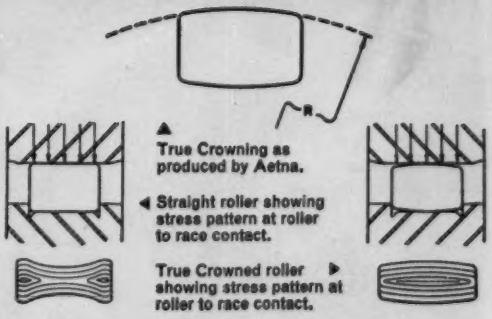


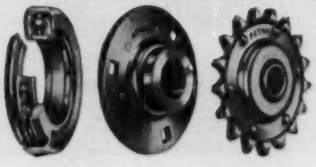
Under extreme load conditions, Aetna True Crowned Roller Bearings have proved their greater efficiency. In exhaustive comparison tests between straight rollers and crowned rollers, utilizing the AFBMA formula, the Aetna rollers recorded an increased load capacity of over 25% and a longer life expectancy of more than 120%.

What does this greater operating efficiency cost you? Absolutely nothing ... Aetna True Crowned Roller Bearings are not premium priced!

So ... when you need roller bearings, consider the greater efficiency of Aetna True Crowned Roller Bearings at no extra cost. They are available in a wide range of self-contained, pure radial standard designs, and can be made to order in many special designs of both pure radial and pure thrust for unusual applications.

For complete information on Aetna True Crowned Roller Bearings, call your Aetna representative listed in your classified telephone directory, or write for General Catalog and Engineering Manual.


R
▲ True Crowning as produced by Aetna.
◀ Straight roller showing stress pattern at roller to race contact.
True Crowned roller ▶ showing stress pattern at roller to race contact.



AETNA BALL and ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION

4600 SCHUBERT AVE.
CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

Circle 439 on Page 19

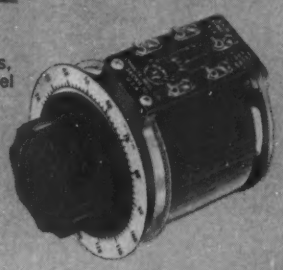
The OHMITE "VT" Series Has

EVERYTHING YOU WANT IN

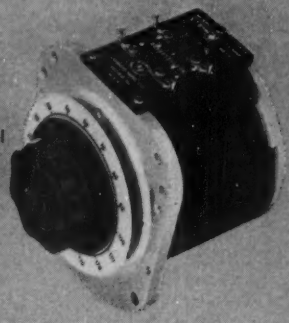
OPEN UNITS

1.5 to 1.8 amps, basic Model VT2

3.5 to 4.75 amps, basic Model VT4



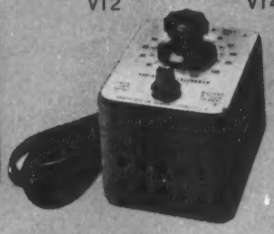
7.5 to 10 amps, basic Model VT8



ENCLOSED UNITS

Fixed, VT2, VT4, VT8

Portable, VT2

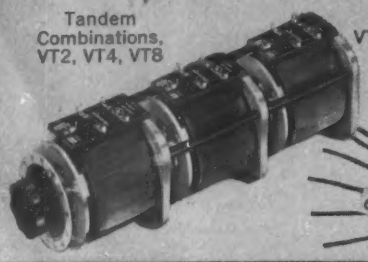


Portable, VT4, VT8

Deluxe Portable, VT8

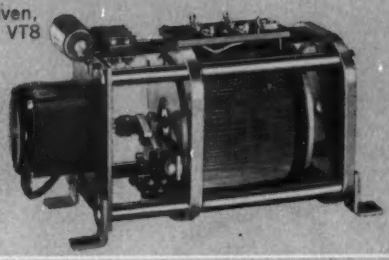
SPECIAL FEATURES

Tandem Combinations, VT2, VT4, VT8



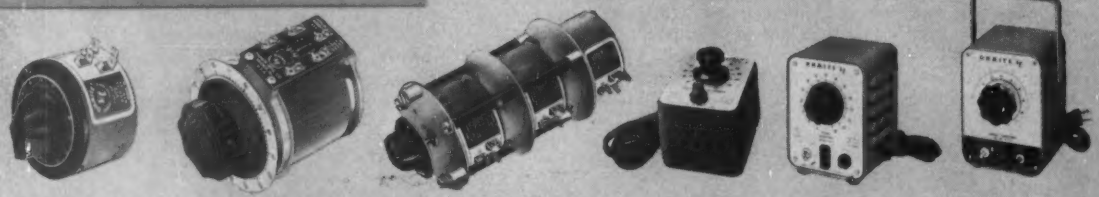
Multi-Tap, VT2, VT4, VT8

Motor Driven, VT2, VT4, VT8



IMMEDIATE DELIVERY

From Distributor and Factory Stocks



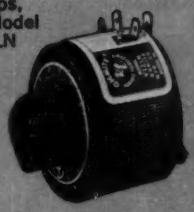
Thirty-eight different types, including individual transformers, two-in-tandem, three-in-tandem, cased, low-voltage, single-phase, three-phase, fixed mounting, portable and accessories.

VARIABLE TRANSFORMERS

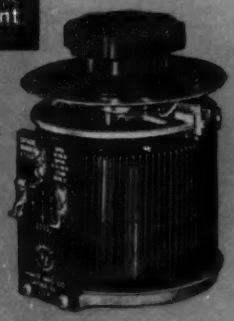
FROM 1.5 TO 10 AMPS

LOW VOLTAGE High Current

36 volts, 5 amps, basic Model VT2LN

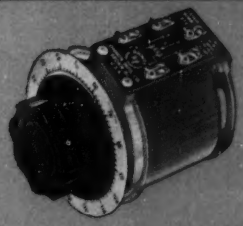


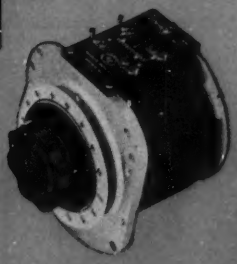
36 volts, 12 amps, basic Model VT4LN



36 volts, 22 amps, basic Model VT8LN

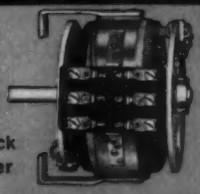
UL APPROVED





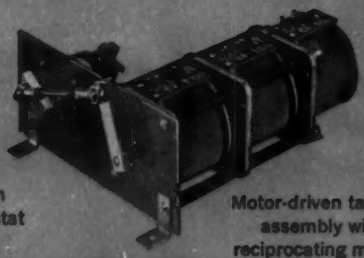
At the present time, Model VT8 carries the UL label.
Model VT4 is undergoing final tests, and VT2 will be submitted soon.

CUSTOM ENGINEERED



Double Track Transformer

With Rheostat



Motor-driven tandem assembly with reciprocating motion

Whether your special needs are mechanical or electrical, simple or complex, Ohmite can engineer and manufacture the job in any quantity you desire. Units shown above are typical examples.

OHMITE "V.t." VARIABLE TRANSFORMERS

Write for Bulletin 151D

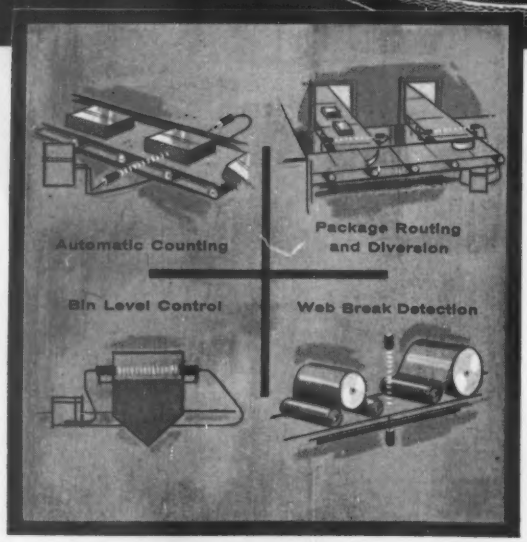
OHMITE MANUFACTURING COMPANY

3618 Howard Street, Skokie, Illinois

Rheostats • Power Resistors • Precision Resistors
Variable Transformers • Tantalum Capacitors • Tap Switches
Relays • R.F. Chokes • Germanium Diodes • Micromodules

OHMITE

a new dimension in automated controls

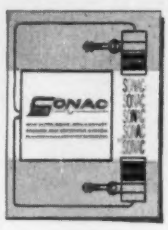


SONAC ULTRASONIC,

NON-CONTACT SENSING AND SWITCHING SYSTEM

Before Sonac, sensing and switching control systems which involved breaking a beam of energy were limited by vibration, dust, smoke, steam, air contamination and too much or too little light. Sonac's ultrasonic energy "beam" is completely free of these limitations. The acoustic lens on Sonac sensors can actually be painted without affecting performance. Utilizing high frequency sound also means there are no lamps to burn out. Savings in replacement parts and maintenance time often means Sonac pays for itself. Sonac is completely transistorized, providing you with a rugged, dependable electronic circuit.

These are just a few of Sonac's many uses. Optional equipment includes reflectors for precision beam and positioning control, and coupler assemblies for use with flexible tubing for remote sensor locations. This descriptive booklet will be sent to you on request.



DELAVAN
Manufacturing Company
WEST DES MOINES • IOWA

Circle 441 on Page 19

We've
joined . . .

IMPERIAL EASTMAN

Happy occasion! The Imperial Brass Manufacturing Company of Chicago, producer of tube fittings and tools since 1905, and The Eastman Manufacturing Company of Manitowoc, Wisconsin, maker, since 1914, of rigid and flexible hydraulic power lines, have now joined hands. Happy occasion for us — happy occasion also, we trust, for our many mutual customers. Imperial-Eastman Corporation. General Offices: 6300 W. Howard St., Chicago 48, Ill.

IMPERIAL EASTMAN

Circle 442 on Page 19

Circle 443 on Page 19→

How General Electric's TRI 55 CLAD motor gives you MORE THAN A MOTOR...

MOTOR SERVICE STATIONS —THROUGHOUT THE U.S.— BACKSTOP YOUR PURCHASE, KEEP YOUR CUSTOMERS SOLD

Service follow-through (or the lack of it) isn't a problem when you select General Electric Tri/Clad '55' motors for your integral-horsepower applications.

A nationwide network of G-E Electric Motor Service Stations offers you a means of getting General Electric Tri/Clad '55' motors repaired promptly and expertly—anywhere in the country. This handy, competent service assures fast repair or replacement for the motors you install in the equipment you sell.

Fast, local backup service is one good way General Electric Tri/Clad '55' motors give you *more* than a motor. Ask your G-E salesman to explain how this motor service plan works for you and your customers. Or send for Bulletin GED-2396, General Electric Co., Schenectady 5, N. Y.

840-32

Other "More Than A Motor" Benefits of G-E Tri/Clad '55' Motors: On-time Delivery • Expert Application Aid • Constant Design Innovation • Durable, Long-life Performance • Complete Line.

GENERAL ELECTRIC

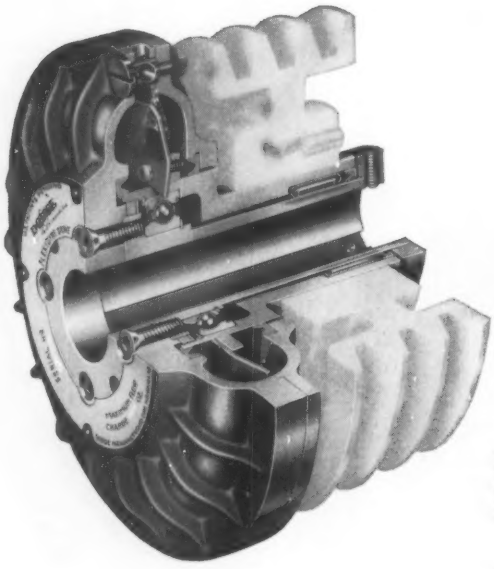
GENERAL ELECTRIC Motor Service Stations are located in every principal town and city. They provide convenient backup service for the G-E Tri/Clad '55' motors you buy.

EXPERT SERVICE SPECIALISTS from General Electric continually visit G-E motor service stations throughout the country; keep them up-to-date on latest motor developments and repair techniques.

TRAINED PERSONNEL in General Electric motor service stations make sure the service you get is fast, competent.

WHAT'S YOUR PROBLEM?...

- ☑ Overheated motors?
- ☑ Excessive belt maintenance?
- ☑ Breakage of materials being processed —like thread, wire, paper?
- ☑ Expense of oversize or high torque motors?
- ☑ High demand rate?
- ☑ Expense of reduced voltage starters?
- ☑ Clutch trouble?
- ☑ Breakage of transmission parts due to instantaneous shock loads?
- ☑ Damage and recurring down-time from overloads?



FLEXIDYNE

THE DRY FLUID DRIVE

It is no longer necessary to accept the destructiveness—the costliness—of conventional starting in the mechanical transmission of power. Flexidyne changes that!

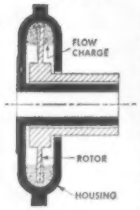
Flexidyne is the new way to start loads *smoothly*—to protect against shock and overload—to save power—all *without any sacrifice of efficiency at full load!*

This revolutionary development is ushering in "the day of the soft start"—which can mean thousands of dollars to you in equipment savings and in better, more economical operation.

Flexidyne is available, off the shelf, in Drives and Couplings. Capacities range from fractional to 1,000 hp. Ask your local Dodge Distributor or write us for technical bulletin.

DODGE MANUFACTURING CORPORATION, 3300 Union St., Mishawaka, Ind.

HOW FLEXIDYNE WORKS



The "dry fluid" in Flexidyne is tiny heat-treated steel shot. A measured amount, called the "flow charge," is contained in the housing, which is keyed to the motor shaft. Inside the housing is a rotor, free to revolve relative to the housing, but connected to the load.

When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor, which transmits power to the load. Initial slippage is momentary. Housing and rotor become locked together and achieve full load speed without slip and at 100% efficiency.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

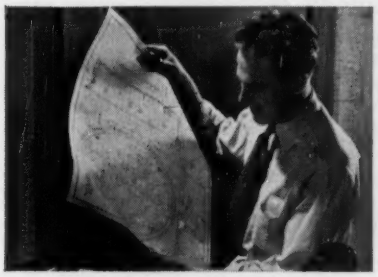
DODGE

of Mishawaka, Ind.

Problem: How to Microfilm Old Drawings So They Can Be Read

Microfilming is widely used for recording and storing the mountains of drawings and data individual companies must maintain. But to anyone who works with microfilmed drawings, they know the condition of the original is very critical in order to obtain a readable microfilm print. Faint lines, weak lettering and dimension markings, creases, and dirt smudges become impossible handicaps when the originals are first reduced 16 to 29 times and then enlarged for reading or reproduction. Today's advanced drafting techniques avoid this problem in new drawings, but what about a company's old drawings? Few are ever suitable for microfilming without extensive, meticulous restorative work. Yet, something must be done with these old drawings if the microfilm file is to be complete and useful.

Dietzgen answers this problem with a number of products and techniques developed for restoring old drawings



Dietzgen's "wash-off" process puts new life into old drawings quickly and inexpensively.

preparatory to microfilming. The Dietzgen "wash-off" process is preferred by many because no darkroom work is involved. Corrections are easily made on the "wash-off" media eliminating the tedious retouching of a photographic negative. Backgrounds come clean with a wipe of a brush or sponge so that even the finest line stands out sharp and clear.

Today thousands of old drawings which appeared hopeless subjects for microfilming have been salvaged by Dietzgen products and techniques . . . and it's this experience which can prove invaluable to you if old drawings have handcuffed your company's microfilm program.

JETS, MISSILES AND DIAZOS

A large manufacturer of components for jet aircraft and guided missiles complained: "We're having trouble getting all the prints we need each day with our present printmaking facilities. We must step up our printing speed. However, we want to standardize on blueline diazo prints and would like to run our printers at very nearly a constant speed. Also, we have to work with a wide range of reproducibles, which really complicates the problem."

Four companies coating diazo papers were given the problem. Two immediately said it was impossible. The third submitted a specially coated stock which provided the speed but not the print quality required.

Dietzgen had answered similar problems before. With a slight formula change in one of the regularly catalogued Dietzgen diazo papers, the extra speed was added to all the other needed characteristics already in formulation. This custom-engineered product was tested and immediately adopted. It has since been used continuously for the company's large volume needs and is pronounced "perfect." Print production soared.

Dietzgen's long and broad experience with Diazo coatings and equally long and broad research program frequently combine to provide both counsel and advanced products not obtainable elsewhere.

Drafting-Printmaking Booklet reports new techniques for solving engineering and production problems

This new 36 page booklet describes a wide variety of engineering and production problems that have been solved with advanced techniques in drafting and printmaking pioneered by Dietzgen. The concise, problem-solution approach suggests ways in which you may improve the efficiency within your engineering department or eliminate production bottlenecks. Write today on your company letterhead for the Mechanics of Modern Miracles. Ask for Publication SPD2-L-160, Eugene Dietzgen Co., Chicago 14, Illinois.

DIETZGEN

EVERYTHING FOR DRAFTING SURVEYING & PRINTMAKING

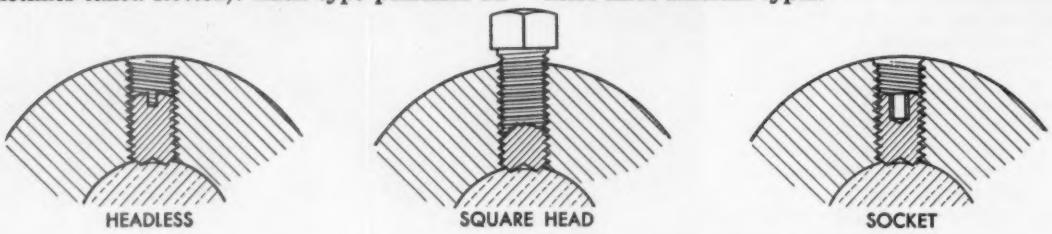
Circle 445 on Page 19

FASTENOMICS

TIPS ON FASTENER APPLICATIONS BY STANSCREW

How to Choose the Best Set Screw for Your Application

American Standards recognize three different types of set screws . . . socket, square head, and headless (sometimes called slotted). Each type possesses advantages for certain particular applications . . . as indicated below. Here are characteristic drawings of these three different types.



All are shown with cup point. All standard points are discussed later.

What's the Best Size?

For the most common set screw application . . . attaching a member to a shaft . . . the diameter of the set screw varies directly with the diameter of the shaft. A common error is to use a set screw that is too small. For maximum holding power, the largest diameter possible should be used, but normally this diameter is limited to 33% of the shaft diameter by the configuration of the mating parts.

Factors to Consider

In selecting a set screw for a given application, the designer's first consideration is, obviously, that the fastener has adequate holding power. He should be governed, in addition, by the factors of safety, appearance, and accessibility in determining the best possible fastener for a specific use.

Selection of the right fastener becomes simplified when we recognize that the three different types of fasteners vary in four ways . . . holding power, conformation, cost, and wrenching technique. Let's briefly review all three types.

Holding Power . . . and How We Get It

The holding power of the set screw depends entirely on the pressure exerted between the point and the thread, and the point's ability to imbed itself. In other words, the holding power depends upon the tightening force which has been applied . . . "the man with the wrench".

Headless set screws, being tightened solely by a screwdriver, can only be tightened to about 75 inch-pounds. Headless set screws should, therefore, be used only for those applications requiring limited holding power, or when limited pressure is desirable to prevent damaging fragile parts.

Socket set screws manufactured of alloy steel are normally tightened by hex keys permitting the application of much greater clamping or holding forces. Normally, in these applications, the clamping force applied is limited only by the strength of the hex key.

The external heads on square head set screws place no limitations on the type of wrenching which may be applied, up to the tensional strength of the screw itself, so that greater wrenching torques and consequent holding power is possible with these fasteners. Normally manufactured of case hardened steel, the strength of the material here can be the limiting factor, since the thread strength, and consequently the holding power, is dependent on the depth of case. It is of the utmost importance, therefore, that when these fasteners are used in applications requiring high holding power, they be of the highest quality.

Conformation is Half the Story

The wise choice for a particular application is often decided by relative conformations . . . bearing in mind the factors of safety, appearance, and accessibility.

For any application, the square head set screw differs essentially from the other two types, in that the square head must project in order to allow the application of the wrench. Sometimes this projecting head creates a safety problem. In other applications it will detract from appearance. And, obviously, in all cases a longer set screw is required if the square head type is chosen.

Accessibility . . . A Must

In selecting the proper set screw, the wise designer should always bear in mind accessibility for repair

and maintenance. For most applications, the socket set screw with its hex key wrenching provides maximum accessibility with high holding power.

How Do Costs Compare?

Size for size, headless set screws are the least expensive; followed by square heads; with socket head set screws requiring the greatest *initial* investment.

On the basis of holding power per dollar, however, square heads provide the greatest possible value . . . followed by socket heads . . . with headless providing the least holding force per dollar spent.

In evaluating costs, remember that for most applications you will need a longer square head set screw, since it must project further from the shaft in order to allow external wrenching. In many applications this may increase the cost of the square head set screw substantially, and change the cost relationships described above.

Which is the Right Point?

Evaluation of the claims made for various points is unquestionably the most controversial area in set screw selection. Although extravagant claims are made for the locking action of many different special point constructions, Stanscrew believes the only function of the point should be to provide good entry into the shaft in order to secure adequate holding power . . . the locking action is the function of the threads. This, the standard cup point does!

Stated another way, set screws should be designed to permit the application of the greatest possible fastening torque by "the man with the wrench". The precise uniformity of thickness, pitch, diameter, and lead of the threads should permit maximum contact and ample friction to lock the screw. The point should be designed to produce maximum holding action by entry into the shaft . . . without any attempt to secure an unnecessary locking action.

Significantly, American Standards recognize only the six points below. In socket set screws, all are made by Stanscrew and other leading manufacturers.

CUP POINT

The most widely used general purpose point. It should be the invariable selection for those applications where semi-permanent assembly is required and where the shaft is soft enough for entry of the cup point.

FLAT POINT

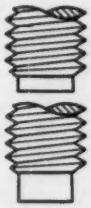
The flat point will not mark the shaft, and is therefore desirable for applications involving continual tightening, loosening, and retightening of the set screw. It is also used in conjunction with a flat on the shaft when the shaft is too hard for the use of a cup point.

CONE POINT

Used where reasonably permanent assembly is desired. The cone point requires the "spotting" or the drilling of a hole in the shaft. For maximum effectiveness with the cone point, the angle should be precisely drilled with a 90° included angle.

OVAL POINT

Again used with a "spotting" hole, the oval point is more adaptable than the cone point—requiring less precision in the angle of the drilled spotting hole—and is sometimes used as a substitute for the cone point.



HALF DOG (and FULL DOG) POINTS

These are used in those applications where it is desired to permit some motion—either longitudinal or rotary—between the parts when used in conjunction with a longitudinal or annular groove. Where a permanent location of one part with another is desired, a hole for the reception of the point is used. The half dog construction is used for the great majority of applications of this type.

Don't Overload Inventory

The wise designer bears in mind the extra costs caused by the stocking of excessive inventories and the maintenance problem resulting from overspecialization in selecting fasteners. Therefore, whenever possible, he uses the minimum possible number of different types and sizes of set screws . . . as well as all other fasteners and components.

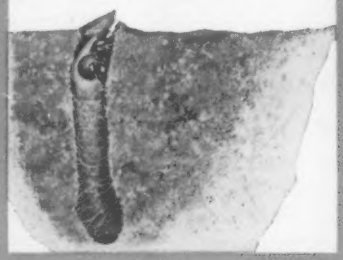
For Further Information

For specific information on a particular problem, simply call your Stanscrew fastener specialist. You can reach him quickly through your local Stanscrew distributor . . . who can also provide over 5,700 different Stanscrew fasteners to supply an economical, dependable answer to the overwhelming majority of all your fastener requirements.

STANSCREW FASTENERS

CHICAGO | THE CHICAGO SCREW COMPANY, BELLWOOD, ILLINOIS
HMS | HARTFORD MACHINE SCREW COMPANY, HARTFORD, CONNECTICUT
WESTERN | THE WESTERN AUTOMATIC MACHINE SCREW COMPANY, ELYRIA, OHIO

STANDARD SCREW COMPANY 2701 Washington Boulevard, Bellwood, Illinois



Underground Spinner. Not all spiders make webs. But all are skillful spinners of strong silk thread, for very different uses ranging from aerial "parachuting" to wrapping up prey. The trapdoor spider digs a deep hole, spins a gossamer coating for it, adds a hinged lid and lives securely in his silk-lined, expertly engineered burrow.

Tiny Thread Transducer. In textile weaving this new Mark III thread transducer — shown greatly reduced in size — helps eliminate moirè patterns by recording average and cyclic thread tension. Friction in the transducer's floating arbor is overcome by three MPB bearings cycled between 10,000 and 20,000 rpm 371 times per minute.

Man With Miracles. Like all MPB Sales Engineers, Harry Gabriel can tell you about the advantages MPB bearings are bringing to new, miniaturized devices like the Mark III thread transducer, throughout the country. For miniaturization of your own products he can also give you expert aid in reducing friction and inertia with MPB bearings.

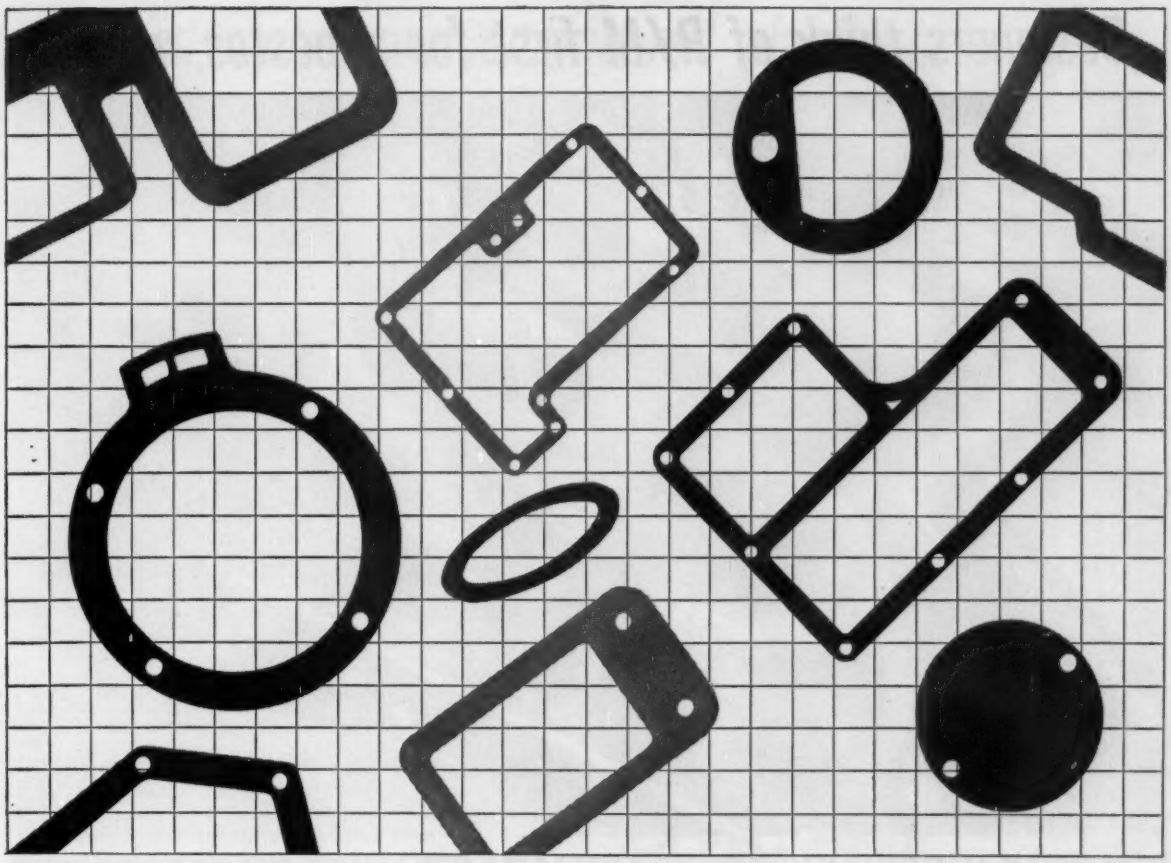
Miracles in Miniaturization

ACTUAL SIZE OF THE MPB BEARINGS IN THREAD TRANSDUCER SHOWN ABOVE

The more than 16,000,000 miniature and instrument bearings produced by MPB have met requirements in over 16,000 different types of applications. Developing bearings to aid in the design and manufacture of smaller, lighter, *better* components has always been a part of MPB service to customers. For details about MPB as a consulting and cooperating force — and for a catalog on MPB bearings, the world's largest line — write to **Miniature Precision Bearings, Inc.**, 811 Precision Park, Keene, N. H.

MPB *Helps you perform miracles in miniaturization*

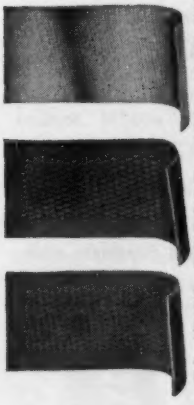
Circle 447 on Page 19



R/M CAPABILITY

develops these outstanding gasket materials

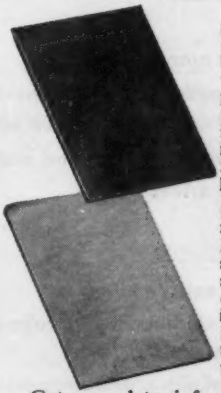
These five gasket materials are outstanding examples of R/M's capability in the development of coated cloths and asbestos sheets to meet the exacting and varied requirements of industry.



R/M No. RL-638. A wire-inserted, woven asbestos fabric coated with neoprene compound and aluminum finish. It is ideal for use as seals against extreme heat and where high-temperature (2000°F) flame penetration resistance is required. Its light weight is a plus value. Meets FAA Specification CAR-046-075 (a) for Fireproof Materials FAA Release #259, Section 1, Part B 1.

R/M No. 606. A silicone-coated asbestos cloth which retains its flexibility even after extended exposure to 500°F and intermittent exposure to temperatures as high as 650°F and as low as −100°F. It also offers excellent resistance to ozone, sunlight and oil.

R/M No. 607. A Teflon*-impregnated asbestos cloth which combines the complete chemical resistance and engineered properties of Teflon with the desirable qualities of asbestos cloth to provide great flexibility, compressibility and abrasion resistance.



R/M FLUOROBESTOS (for LOX and cryogenic service). A high grade, long-fiber asbestos unwoven sheet thoroughly impregnated with Teflon. It has the same sealing and physical characteristics as compressed asbestos sheet, with the added benefits of Teflon. Low cold-flow characteristics permit its use in continuous and cycling temperatures to 550°F. It is serviceable at temperatures as low as −300°F.

R/M No. A-56. A compressed asbestos sheet made from spinning grade long-asbestos fiber. Its binder is a heat resistant, nonreverting synthetic compound. It has an average tensile strength of 8000 psi and is the only compressed asbestos sheet made commercially in thickness of .008 in. ±.001 in. It has high heat resistance — is withstanding flange temperatures of 900 to 1100°F where internal temperatures are as high as 1400°F.

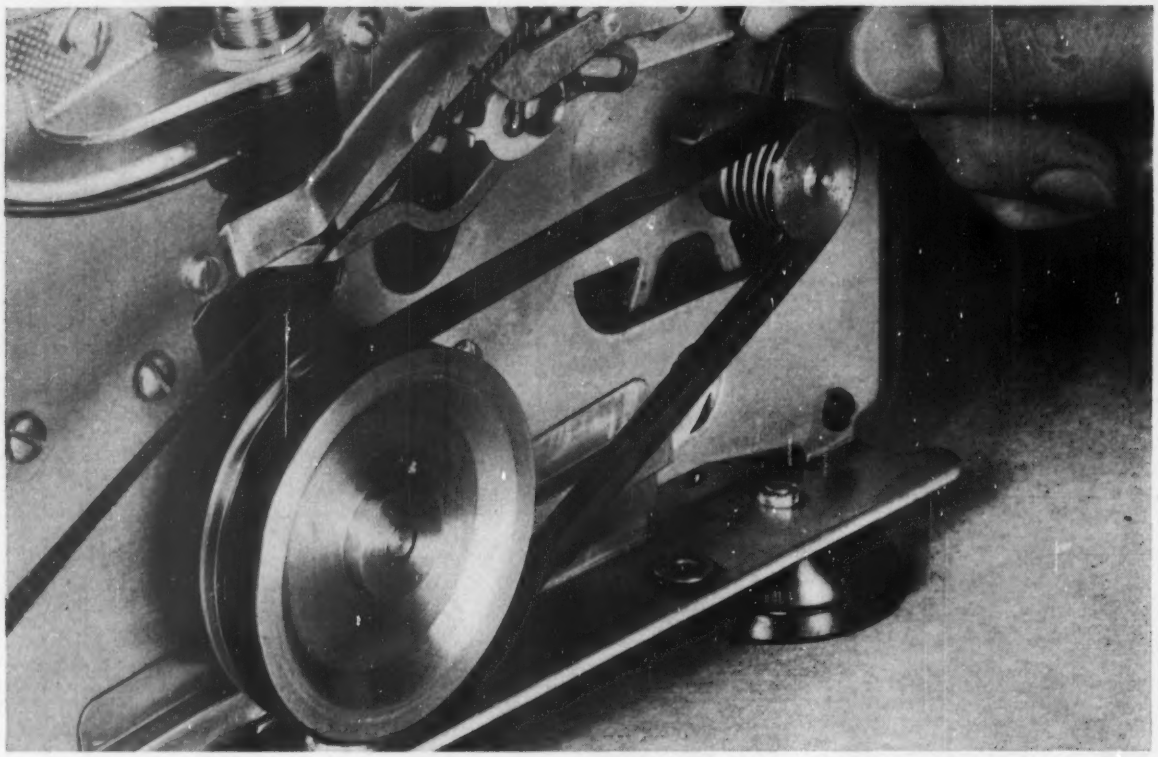
Get complete information about these and other R/M gasket materials. Write for our Mechanical Packings and Gasket Materials Catalog. And remember R/M experience in the manufacture of these products is at your disposal — call on us whatever your needs.

*Registered trademark for Du Pont fluorocarbon resins

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Circle 448 on Page 19

Designers think of R/M first for asbestos, rubber,



R/M POLY-V® DRIVE "J" OFFERS ADVANTAGES NEVER BEFORE POSSIBLE

Design advantages sought for years for small machinery drives are now available exclusively in Poly-V Drive "J"—utilizing a single parallel V-ribbed belt running on space-saving sheaves grooved to mate precisely with the belt ribs. Only R/M Poly-V "J" offers . . .

- **Silent, vibrationless drive operation**
- **No splice on traction surface**
- **Requires less space—is cooler running**
- **Designed especially for small pulleys—as small as .8" diameter**
- **Positive groove tracking—will not wander or run off sheaves**
- **Will operate in any position and on ¼ turn and mule drives**
- **Ideal for serpentine or tandem drives**
- **High RPM and belt speeds**
- **Highly efficient**
- **Long life with either inside or outside idlers**
- **Exceptionally small mounting clearances and take-up. Permits reduction of housing and cover casting size**
- **Absorbs shock—gives overload slip protection against machine damage**
- **Does not lose efficiency with wear—gives longer life for belt and sheaves**
- **Heat and oil resistant—requires no lubrication or belt dressing**
- **Exceptional flexibility—operates easily with midget motors**

(Patented U.S. and foreign countries)

Engineered Specially for—

Small Sheaves and Short Centers Wherever Balance, Reliability and Silent, Vibration-Free Performance are required.

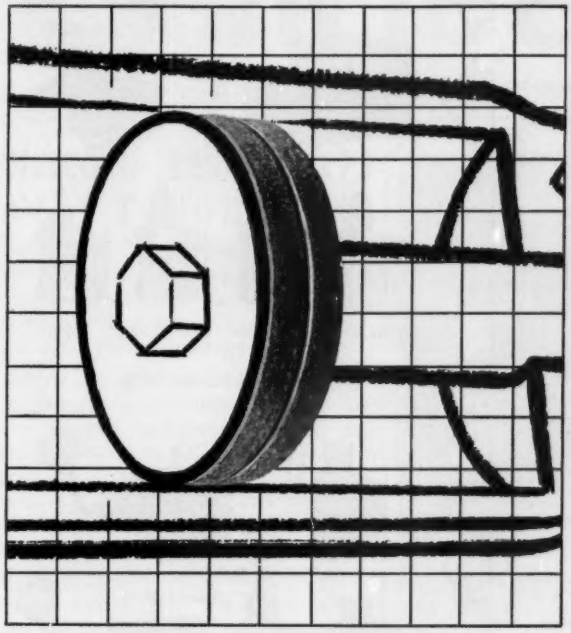
MORE power in LESS space than conventional V-Belt Drive with no matching or turnover problems. Write for Bulletin M142.

For medium and heavy duty drives R/M Poly-V is available in the larger "L" and "M" Sections. Write for Bulletin M141.

Wherever your problems involve Power Transmission Drives, V-Belts, Flat Belts, rely on R/M Products and Engineering Services.

Write today for free booklet shown: full details on a wide variety of industrial rubber products. MANHATTAN RUBBER DIVISION, RAYBESTOS-MANHATTAN, INC., PASSAIC, N. J.

sintered metal, and engineered plastic products



R/M CAPABILITY

develops precision-molded piston cups for perfect seals that last and last

You can be sure of minimum friction, highest resistance to extrusion, and positive sealing action with R/M precision-molded piston cups. Compounds have been carefully developed by R/M's chemists to provide maximum service in a wide range of applications. Careful quality control assures dimensional uniformity, clearly defined contours, and cleanly trimmed edges.

Two types are available: R/M 1400 Series, manufactured from duck and synthetics; R/M 1501, from asbestos fabric and synthetics. Both are custom made to fit specific applications. Diameters range from ½ to 12 in. They can be furnished in varying degrees of hardness for pressures to 1500 psi. And R/M's vast experience in designing and manufacturing packing and gasket materials is at your disposal. Send us data on your application.

PACKINGS

Write for free brochure giving complete information on R/M Molded Hydraulic and Pneumatic Packings. Packing Division, Raybestos-Manhattan, Inc., Passaic, N.J.

ADHESIVE PROBLEMS SOLVED HERE

Here in the Raybestos-Manhattan adhesives laboratory at Bridgeport, Conn., our engineers can solve even your most difficult adhesive problems.

R/M manufactures a wide range of Ray-BOND® adhesives. For special requirements, R/M will tailor special adhesives . . . designed to meet your particular manufacturing techniques, the demands of the materials you are using, and the service conditions of your product.

Take advantage of R/M's more than 20 years of experience in the production of bonded assemblies and the manufacture of adhesives, coatings and sealers. Why not call on Raybestos-Manhattan engineers today, without obligation, and ask them to prove how they can help you cut costs, speed production, and simplify fabrication and assembly operations.

ADHESIVES

New R/M Bulletin No. 701 contains helpful engineering information on Ray-BOND adhesives, protective coatings and sealers, casting, encapsulating and potting compounds. Write for a copy today. Adhesives Division, Raybestos-Manhattan, Inc., Bridgeport, Conn.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C.
Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

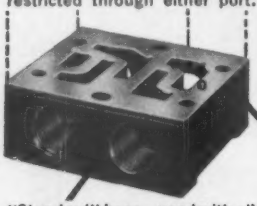
R M

Circle 450 on Page 19 ▲

Circle 451 on Page 19 ▲

This basic CC body is the "heart" of every CC valve. Its one moving part is the "spool poppet", a Hannifin exclusive that seals bubble tight at either end of its short stroke. Note the ample air passages—all ¼" IPS or larger. This is single-actuator, spring return version.

Speed control section, optional—designed to restrict exhaust flow, only, through either or both cylinder ports. Flow to the cylinder remains completely unrestricted through either port.



"Standard" base—used with all but foot-operated models. Every CC base is available tapped either ¼" or ⅜" IPS.

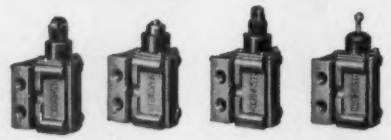
Optional base for "O" ring gasket mounting. Supplied complete with 4 O-rings.

This is the same body with double-end "spool poppet"—used when two actuators are required.

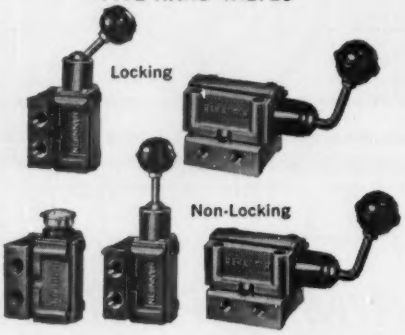
For foot-operated valves, the actuator is also the base, and this rear-ported adapter is used. Available tapped either ¼" or ⅜" IPS.

"Universal" base, tapped from beneath and from both sides. Four pipe plugs supplied. Can also be used with O-rings.

SINGLE ACTUATORS
(Spring Return)



FIVE HAND VALVES

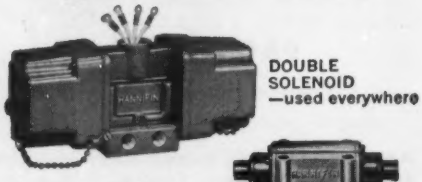


TWO FOOT VALVES

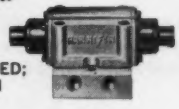
TYPICAL COMBINATIONS
(Hundreds Available)

FOOT-OPERATED, LOCKING; PRESSURE OVER-RIDE —used on foundry machinery

CAM-OPERATED; PRESSURE-RETURN —used on automatic wash tanks



DOUBLE SOLENOID —used everywhere



PRESSURE-OPERATED; PRESSURE-RETURN —used everywhere

THESE QUICK-RESPONSE 4-WAY VALVES MOVE AIR DOWN THE LINE—FAST!

Hannifin CC valve design is the reason. Short, positive strokes of the "spool poppet" open up instant and ample passages for air.

Actuation? Any way you want it!

One basic body with a wide selection of operating heads and bases—all with or without our new speed control section—give you over 3,000 choices. We can help you make the right choice . . . through our field engineering service. Call your nearest Parker-Hannifin office or write us direct for full information.

HANNIFIN COMPANY
A DIVISION
515 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3138 PH.

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 79

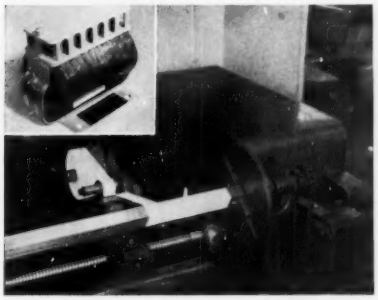
SILICONE RESIN HELPS MEET TOUGH SPECS

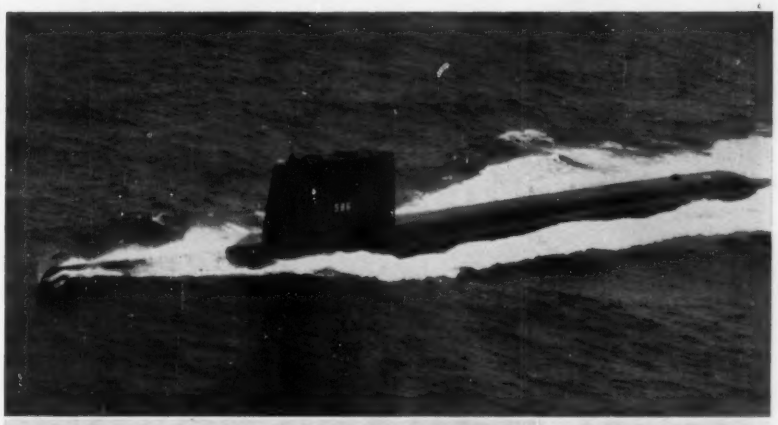
Solventless silicone resin helps meet stringent reliability requirements. Example: transformer start tubes manufactured by Osborne Electronic Corporation, Portland, Oregon.

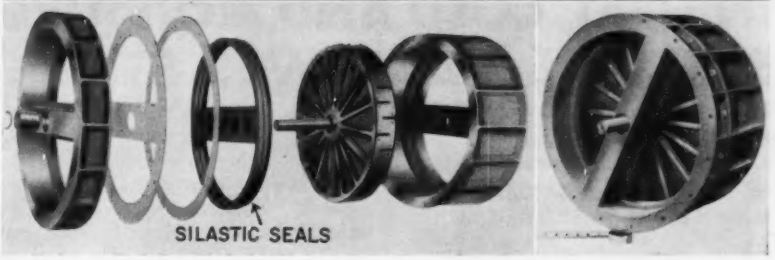
Osborne manufactures specialized high-performance transformers that are virtually standard equipment on major jets, such as the B-52, KC-135 and 707. To produce top quality start tubes of special sizes and shapes, Osborne engineers wrap glass tape on a mandrel, saturate it with Dow Corning solventless silicone resin, and then cure the tube form by heating.

These silicone-glass tubes meet all of Osborne's construction, performance and reliability requirements:

a. Retain mechanical and dielectric strength from —65 to 200 C . . . resist intermittent exposure to 250 C. *(Cont. Pg. 2)*







DESIGN "THROUGH" SEALING PROBLEM

Silicone engineering materials often enable you to design "through" rather than "around" a problem. A heat exchanger manufactured by the Air Preheater Corporation, Wellsville, N.Y., provides a fine example.

Air Preheater makes rotary regenerative heat exchangers for atomic submarine air purification systems. When these extremely compact units are in operation, heat of the purified air pre-warms the stale air before it goes to the catalyst bed. Thus, the air entering the system is raised from room temperature to 575 F, and the purified air is cooled from 650 F to 175 F. This procedure, designed to aid efficiency, saves a combined heating and cooling load of about 70 kw.

Heart of the heat exchanger is the rotor . . . and sealing the rotor seemed like a major design problem . . . until Air Preheater engineers designed through the problem with Silastic®, the Dow Corning silicone rubber.

The Silastic foam cushion seal remains resilient in high temperature service; withstands compression loading created by rotor expansion; and has good resistance to friction and tearing action of the rotor. According to the designers, much of the success of the preheater can be attributed to the method of sealing. *No. 241*

New Insulating Effectiveness

A new, more durable, kind of wire and cable insulation that performs reliably under adverse operating conditions . . . is described in this special bulletin for electrical and electronic designers.

The insulation is Silastic®, the Dow Corning silicone rubber. A flexible material that's really tough, it opens new design concepts for wire and cable . . . provides low cost insurance against failure.

This new fact-filled, six-page bulletin cites typical applications in aircraft, appliances, commercial and industrial building, shipboard, and electrical and electronic equipment . . . points up how engineers are utilizing the properties of Silastic insulated wire and cable to best advantage.

Longer service life of Silastic is attributable to its excellent heat stability, resistance to ozone, corona and oxidation, flexibility at low temperatures, good weathering and storage stability.

To obtain a copy of this engineers' reference — to learn how Silastic wire and cable insulation can help you design equipment that will perform longer and more reliably despite heat, cold, moisture, weathering, corrosive vapors, ozone and corona, circle . . . *No. 242*

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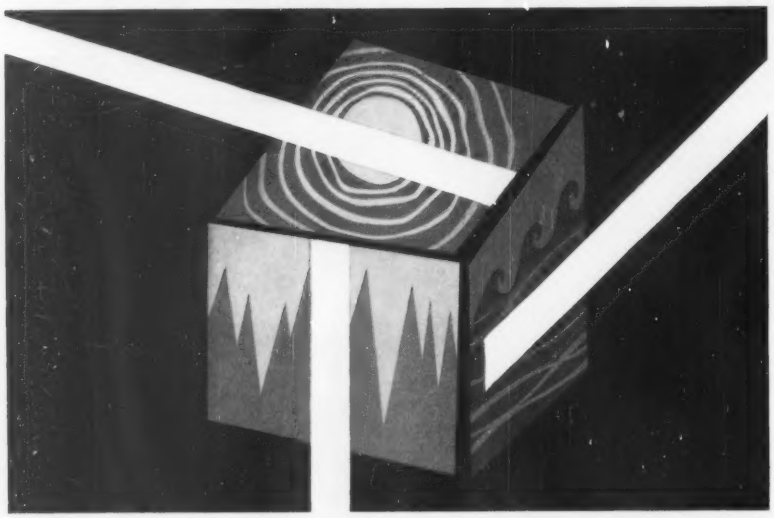
MORE



IN HEAT, COLD AND MOISTURE SILICONE ADHESIVES STICK!

The exceptional durability of pressure-sensitive silicone adhesives makes them dependable for tapes, sealants, spray-on coatings, bonding materials and splicing agents.

• **They stick anywhere!** At temperatures from —80 to 500 F, pressure-sensitive silicone adhesives stay stuck and don't deteriorate. They withstand the effects of moisture, oxidation, corrosive chemicals, weathering, arcing, corona and fungus. For electrical applications, silicone adhesives provide excellent dielectric strength.

• **On tapes.** Dow Corning silicone adhesives are used with most backing materials. Now readily available from several manufacturers are tapes with backings of glass cloth, Teflon, Mylar, aluminum foil, silicone rubber and combinations of these materials. Typical applications include: high temperature electrical insulation; bonding, splicing, and sealing; masking in chemical milling, and release surfacing.

• **Or alone.** For positive, dependable fastening in rugged service, some designers use silicone adhesives to seal heat elements in appliances, bond mica and asbestos panelboard, and bond silicone rubber to the coils of electrical equipment.

Dow Corning Silicones may well be your adhesive of the future. *No. 243*

SILICONE RESIN *(Cont.)*

b. Cure bubble-free without voids or pin holes. Easily applied by brushing, the solventless silicone resin penetrates completely and uniformly.

c. Readily withstand wire winding pressure without distorting.

d. Are easily fabricated in short runs, in great variety, with simple tools. Require only a heat cure, no pressure. Cured forms are easily cut, notched and machined.

The reliability of the silicone-glass start tubes and Osborne transformers has been proved repeatedly by the thousands of transformers now in service. Comments Osborne's chief engineer: "In destruction tests in which the transformer coil is deliberately burned out by overloading, the silicone-glass start tube is blackened but retains most of its electrical and mechanical strength." *No. 244*

new literature and technical data on silicones

We've recently published a series of new booklets, each describing the silicone products of interest to a specific industry. These references cite how different forms of silicones can help you design products that perform more reliably and meet requirements encountered in diverse applications. Send for your reference copy.

Silicones for the Automotive Industry is the subject of an 8-page brochure that cites illustrations and descriptions of the many research, engineering, and automotive production applications wherein silicones make possible superior performance. Some of the applications include power plants, braking systems, power transmissions, electrical components, surface protection, lubrication, and many more applications of interest to every design engineer. *No. 245*

Electronics Engineer's Guide describes all the silicone products that contribute to reliability, miniaturization and environmental protection of electronic components. From satellites to seismographic instruments, this 16-page electronics engineer's guide describes the various forms of silicones that help improve design. *No. 246*

Silicones in Appliances can give that extra edge for extra sales. This colorful booklet tells where and how silicones are being designed into appliances to give more efficient and reliable performance. Illustrations show how planning around silicones can make good products better. *No. 247*

Space Age Silicones are described in thirty typical application stories. Utilization of silicone compounds, fluids, lubricants, protective coatings, rubbers, resins, potting materials and sealants are illustrated for your consideration. This valuable brochure offers solutions to many problems encountered in designing space age aircraft and ground support equipment. *No. 248*

Now available: How Silicones Work for the CPI. Chemical process engineers will find this the most comprehensive description of how and where silicones can be utilized to expand capacity, cut costs, increase reliability, and improve ambient conditions for their industries. *No. 249*

Dow Corning Corporation, Dept. 4911, Midland, Michigan

Please send me: 241 242 243 244 245 246 247 248 249

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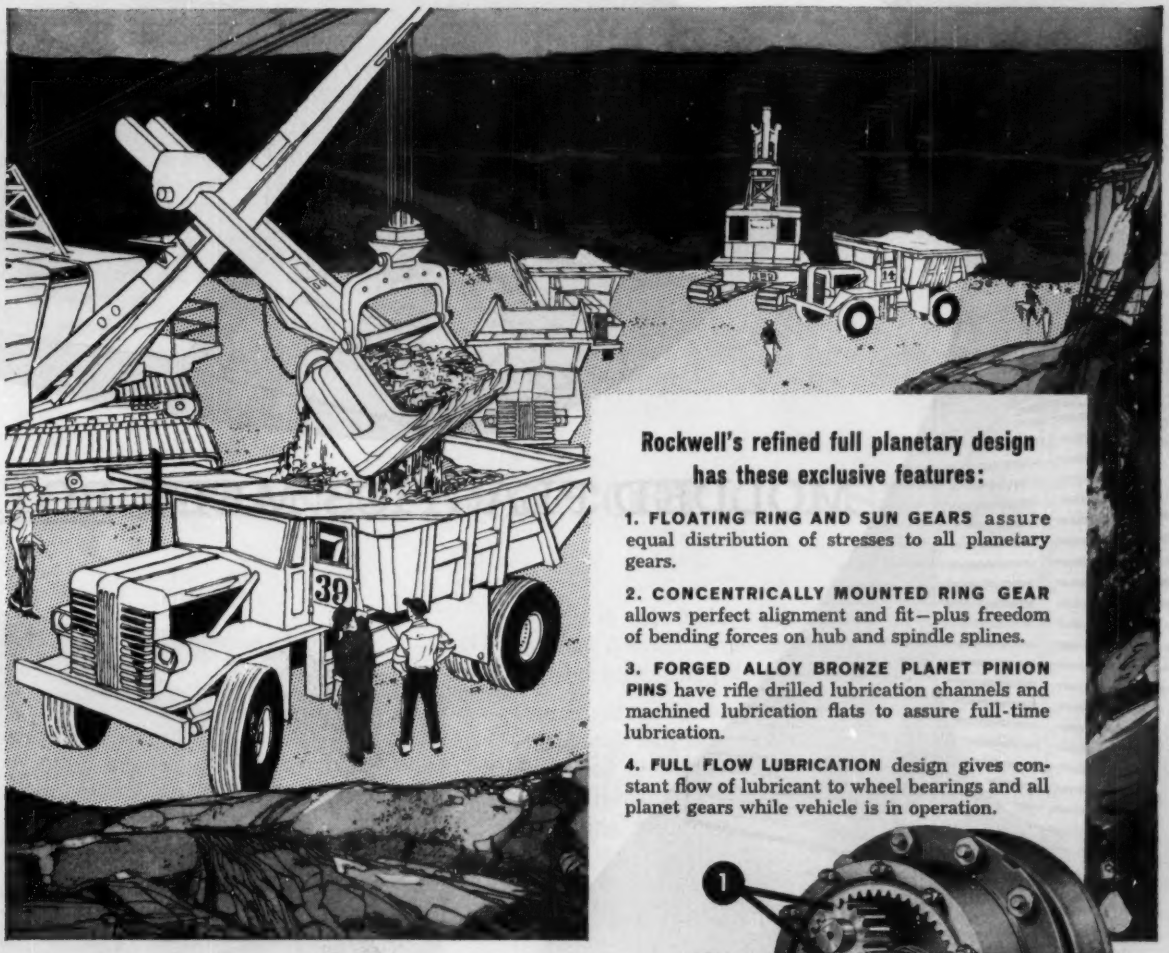


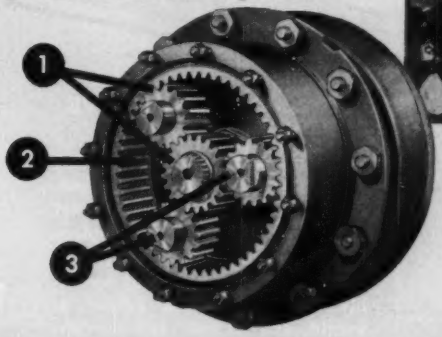
Rockwell's refined full planetary design has these exclusive features:

1. **FLOATING RING AND SUN GEARS** assure equal distribution of stresses to all planetary gears.

2. **CONCENTRICALLY MOUNTED RING GEAR** allows perfect alignment and fit—plus freedom of bending forces on hub and spindle splines.

3. **FORGED ALLOY BRONZE PLANET PINION PINS** have rifle drilled lubrication channels and machined lubrication flats to assure full-time lubrication.

4. **FULL FLOW LUBRICATION** design gives constant flow of lubricant to wheel bearings and all planet gears while vehicle is in operation.



"TIMKEN-DETROIT® PLANETARY AXLES

BEST DRIVE FOR THE HEAVYWEIGHTS!"

Here's new rugged dependability for prime movers, four-wheel tractors, heavy off-road wagons, mining and agricultural equipment, and many other heavy-duty applications. Rockwell-Standard's complete line of planetary axles are available in capacities up to 150,000 pounds. And to meet every job need, there is a planetary steering axle operationally matched to each rigid planetary in the line.

The large reductions possible with Rockwell's full planetary, double-reduction axles enable them to ideally perform most heavy-duty off-highway operations. Because the substantial planetary reduction is located in the wheel hub, axle shafts and first reduction gears carry only nominal torsional loads—give long trouble-free service. For the best heavyweight drive, specify Timken-Detroit.

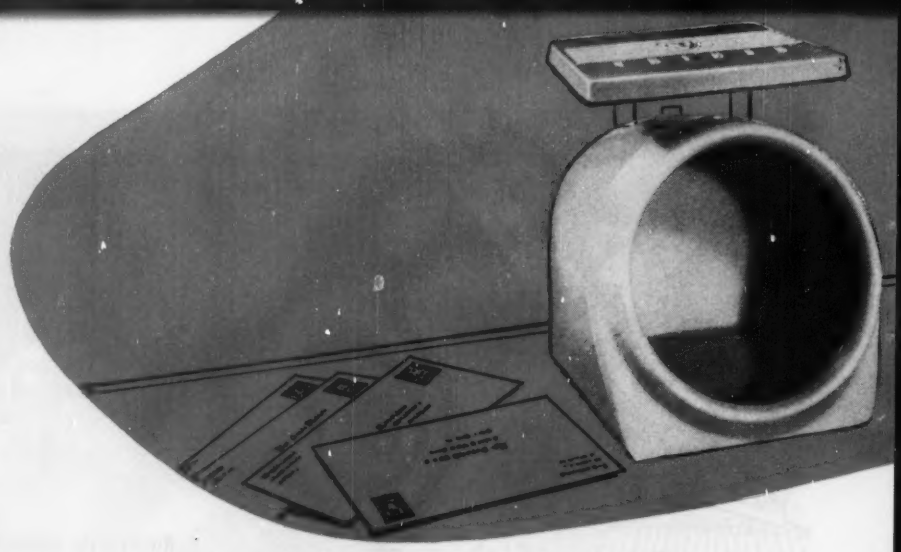
Another Product of...

ROCKWELL-STANDARD CORPORATION

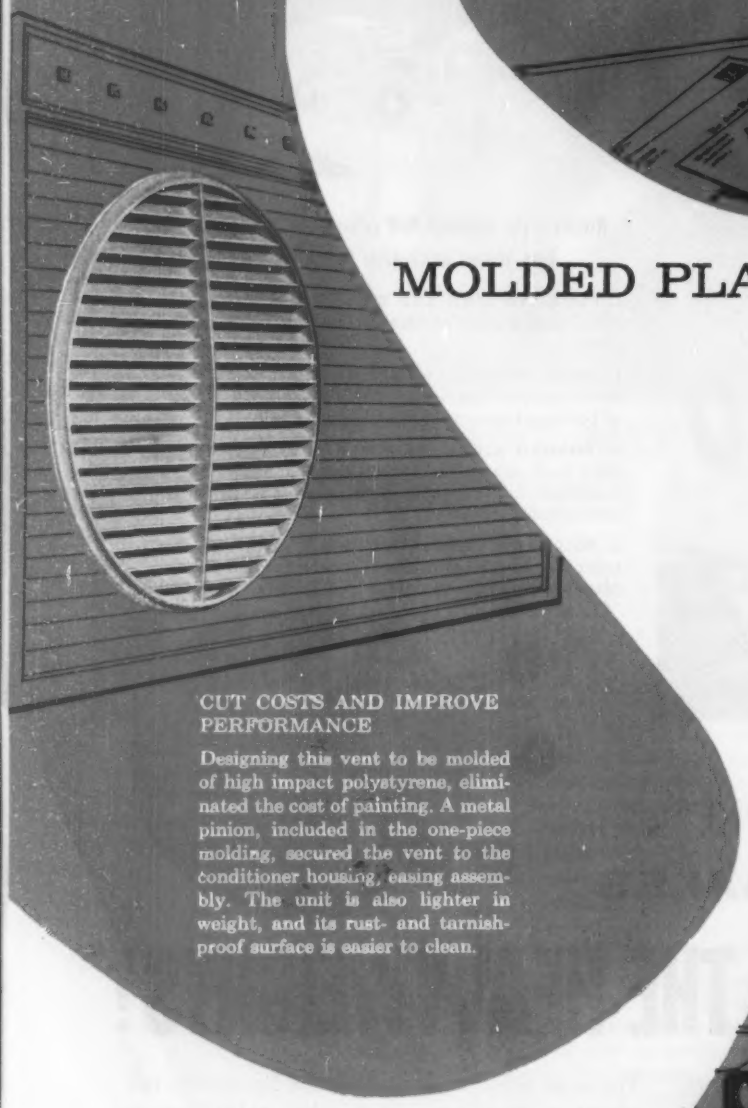
ROCKWELL R STANDARD®

Transmission and Axle Division, Detroit 32, Michigan

Circle 454 on Page 19

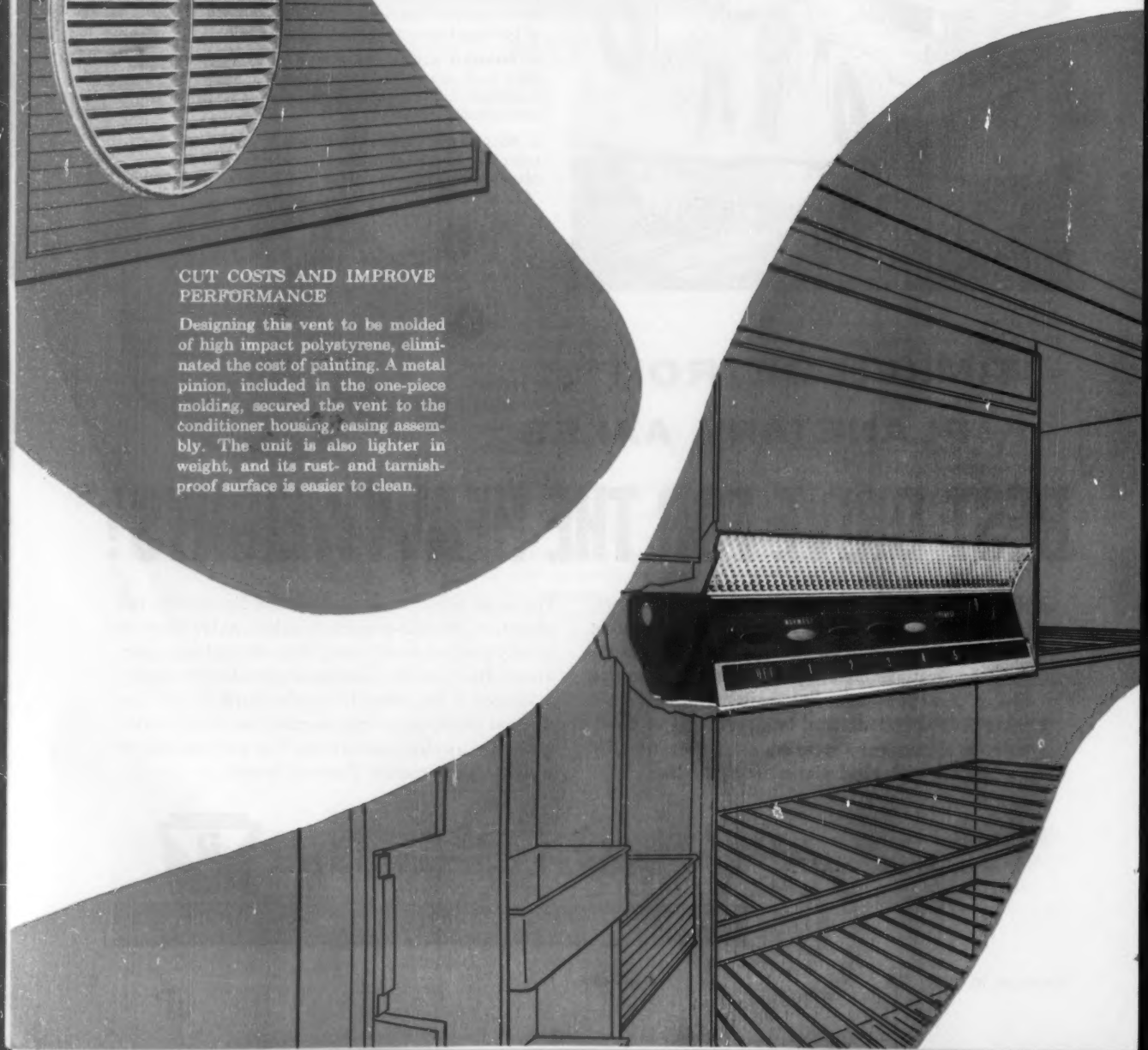


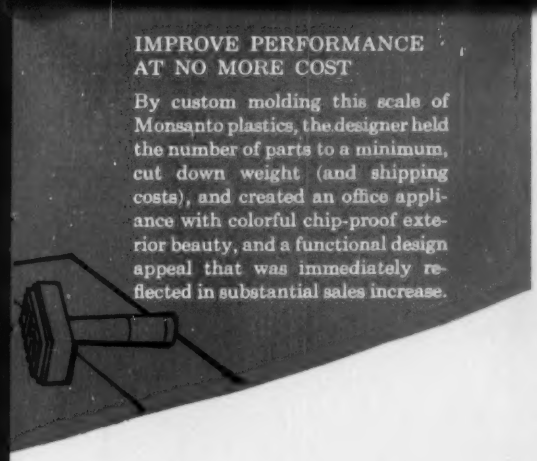
MOLDED PLASTICS MEET BOTH



CUT COSTS AND IMPROVE PERFORMANCE

Designing this vent to be molded of high impact polystyrene, eliminated the cost of painting. A metal pinion, included in the one-piece molding, secured the vent to the conditioner housing, easing assembly. The unit is also lighter in weight, and its rust- and tarnish-proof surface is easier to clean.

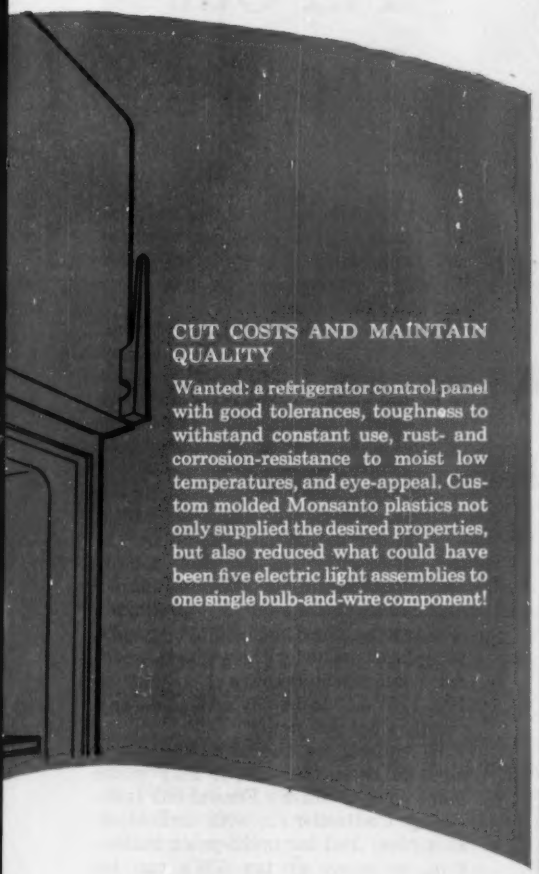




IMPROVE PERFORMANCE AT NO MORE COST

By custom molding this scale of Monsanto plastics, the designer held the number of parts to a minimum, cut down weight (and shipping costs), and created an office appliance with colorful chip-proof exterior beauty, and a functional design appeal that was immediately reflected in substantial sales increase.

PERFORMANCE AND COST CONSIDERATIONS



CUT COSTS AND MAINTAIN QUALITY

Wanted: a refrigerator control panel with good tolerances, toughness to withstand constant use, rust- and corrosion-resistance to moist low temperatures, and eye-appeal. Custom molded Monsanto plastics not only supplied the desired properties, but also reduced what could have been five electric light assemblies to one single bulb-and-wire component!

Why is it that molded plastic can offer wide design latitude—the welcome freedom to develop product ideas with eye and sales appeal without sacrificing performance for price?

One reason, as demonstrated by the examples opposite, is the unique efficiencies and economies inherent in custom molded plastics. Simplified production, for instance. Multiple parts molded in one piece. The elimination of finishing steps—buffing, grinding, tapping, cementing, machining. The unlimited color choice—molded in, not painted on. The close tolerances held even in high speed mass production. The lighter weight for easier handling, lower shipping cost.

There is a wealth of plastics molding compounds with constantly improved combinations of properties, from which to select a material that will match both cost and quality end-product demands.

And last, there's the custom molder. Well known as a mass producer, he is much more. He knows the design capabilities of the many plastics. He can recommend the best formulation, engineer the mold to capitalize on the advantages of molding techniques. He can turn out plastics parts with unusually consistent quality, at rates to meet the tightest schedules and budgets.

As a handy guide for designers, Monsanto has developed a "Plastics Properties Calculator." Send coupon below for yours.

Monsanto supplies custom molders with molding formulations of Monsanto Polyethylene, Lustrex® Styrene, and Opalon® Vinyl, specially developed and constantly perfected to meet the widening range of design requirements.

Monsanto

MONSANTO INITIATOR IN **PLASTICS**

Circle 455 on Page 19

MONSANTO CHEMICAL COMPANY
Plastics Division—Room 722
Springfield 2, Massachusetts
Please send me a free "Plastics Properties Calculator"

Name_____

Title_____

Firm_____

Address_____

City_____ Zone____ State____

Another example of how

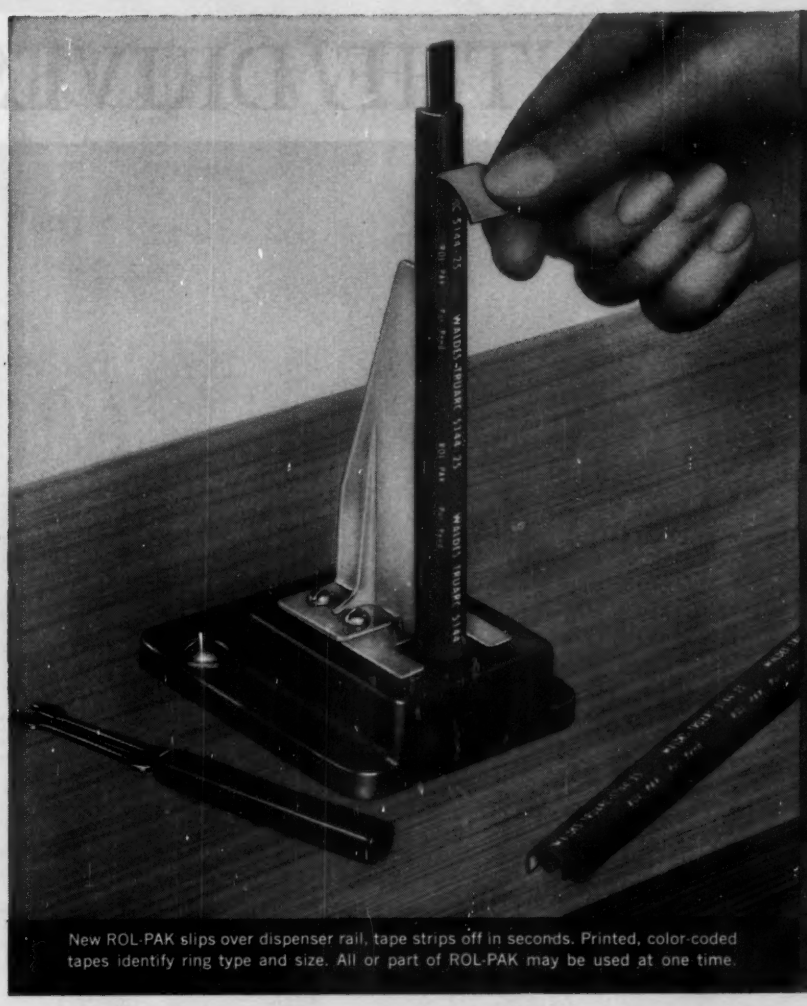
You Fill Out The Tag...

You can choose your own performance features when you order a Fenwal 536 Temperature Controller. And get them in a *compact, low-cost, transistorized stock instrument!*

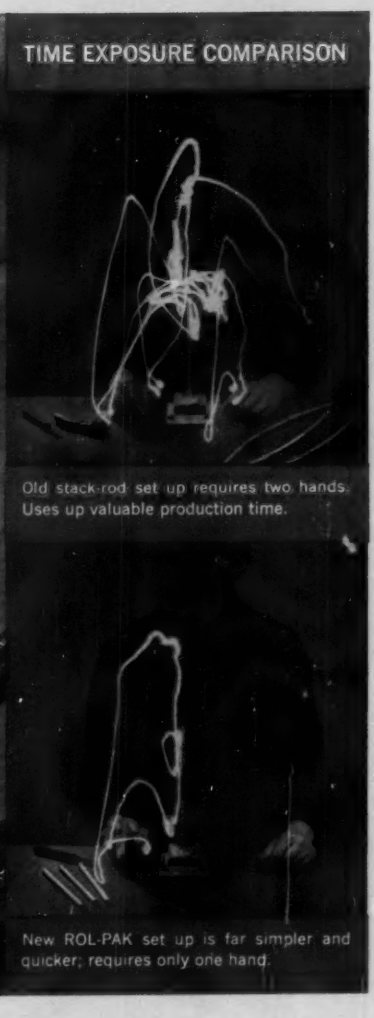
Basic member of Fenwal's new "500" family, the "536" *always* provides precise control action. You merely select from the following features to meet your specific needs: 1. Proportioning or On-Off Control. 2. Five standard temperature ranges from −50 to +600°F (Special ranges, expanded scales, and centigrade scales available). 3. Dial for set-point adjustment externally or internally mounted. 4. Separate potentiometer with graduated dial and knob for remote adjustment. 5. Cartridge, hex head, flange or coupling head probe for thermistor sensor. All configurations have a rating of 10A-115VAC or 5A-230VAC. *You buy exactly what you need!*

Of course, for the user who needs most of these features, it may make more sense to order a Fenwal 561 Indicating Controller . . . with indication as a *plus*. And for multi-point indication, as many as ten 536's can be plugged in to a 580 indicator. Get catalog on the complete "500" Line. Write FENWAL INCORPORATED, 1913 Pleasant Street, Ashland, Massachusetts.

Fenwal CONTROLS TEMPERATURE . . . PRECISELY



New ROL-PAK slips over dispenser rail, tape strips off in seconds. Printed, color-coded tapes identify ring type and size. All or part of ROL-PAK may be used at one time.



Old stack-rod set up requires two hands. Uses up valuable production time.

New ROL-PAK set up is far simpler and quicker; requires only one hand.

New Truarc ROL-PAK speeds ring assembly, handling

ROL-PAK* is a new method of pre-stacking retaining rings for faster, more economical assembly on production lines. Pre-stacked on a color-coded tape, the rings are quickly identified by type and size. Available to users of Truarc Retaining Rings exclusively, ROL-PAK provides production flexibility, and allows faster and more efficient assembly set-up.

On your production line, ROL-PAK slips over the dispenser rail ready to use. The pressure sensitive tape is stripped off in seconds. With the old stack-rod packaging, by contrast, an operator had to remove the cotter pin, hold the bottom rings on the rod to prevent their slipping off then carefully position the rod on the dispenser rail . . . a much more time consuming, less-efficient method.

Here are important ROL-PAK advantages for you to consider: *Faster assembly* because of quicker, easier loading as illustrated above. *Easier identification* of ring size and type, right on the printed, color-coded tapes. *Greater flexibility* since all or part of ROL-PAK may be used. *Easier handling, storage* with no protruding stack-rods.

ROL-PAK is available in Truarc Series 5103 Crescent® rings, 5133 E-rings and 5144 Reinforced E-rings in most widely used sizes. All present types of Truarc ring dispensers may be easily converted to ROL-PAK.

The design advantages of Truarc retaining rings, have led to their ever increasing use in production of products of all kinds. The new Waldes Truarc Assembly Tool Catalog AT 10-58 covering assembly tools, pliers, applicators, dispensers and grooving tools belongs in your files—write for it. And on special application problems, Waldes Truarc engineers will be glad to help. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y.

*Pat. Pending ©1959 WALDES KOHINOOR, INC. 9.10

WALDES

TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

THE MAN & THE DRIVES

FROM WESTINGHOUSE

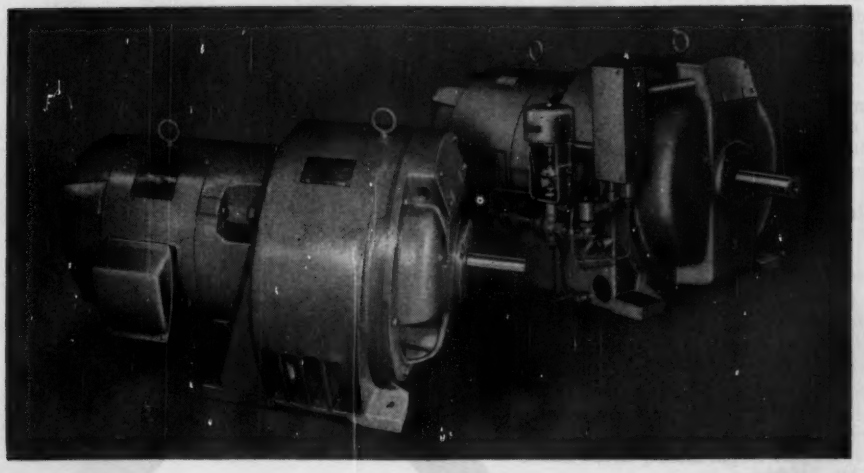
Mr. Westinghouse and MagnaFlow Drives Bring Simple Solution to Speed Control Problems, Save Money and Space, Too!

Westinghouse MagnaFlow* electromagnetic drives—air or liquid cooled—provide infinitely adjustable speeds from standstill to top speed with regulation guaranteed at $\pm 2\%$ of top speed over a 17-to-1 speed range (even closer regulation when desired). Control is smooth and stepless.

These compact drives, having a minimum number of parts, are built for rough, trouble-free service. The unique electromagnetic coupling maintains adjustable output speed without the use of pulleys, belts, brushes, commutators, slip rings or rotating windings. A rugged Life-Line® "A" motor supplies reliable a-c drive power. No power converting equipment needed—only a small, static exciter and an operator's control station. Initial cost is low; installation—easy and inexpensive.

Your Man from Westinghouse is ready now to help you apply MagnaFlow drives . . . and any other drives you may need. Call him . . . or write for a copy of Westinghouse MagnaFlow Electromagnetic Drives (B-7875), Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse. J-22162

*Trade-Mark



MagnaFlow drives—air cooled (foreground) and liquid cooled—are available in various horsepower ratings for winders, conveyors, fans, pumps, extruders and other machinery in all industries.

Westinghouse

Circle 458 on Page 19

BUILD IN STRENGTH AND LIGHT WEIGHT WITH N-A-X FINEGRAIN STEEL

In a wide variety of applications N-A-X FINEGRAIN—a low-alloy high-strength steel—can bring important weight savings without sacrifice of strength and safety. When you design N-A-X FINEGRAIN into your product, you get *all* these advantages:

- It is 50% stronger than mild carbon steel.
- Polishes to a high luster at minimum cost.
- Can be cold formed readily into difficult stampings without surface disturbances.
- Is stable against aging.
- Has high fatigue life with great toughness.
- Has greater resistance to wear and abrasion.
- Is readily welded by any process.
- Offers greater paint adhesion.
- Has twice the resistance of carbon structural steel to normal atmospheric corrosion.*

*Where greater resistance to extreme atmospheric corrosion is important, our N-A-X HIGH-TENSILE is recommended.

Sound like something for you? A thoroughly competent metallurgical service organization is available to work with you on any application problem you may have. Write, wire or phone Product Development Department, Great Lakes Steel Corporation, Detroit 29, Michigan.

N-A-X FINEGRAIN STEEL

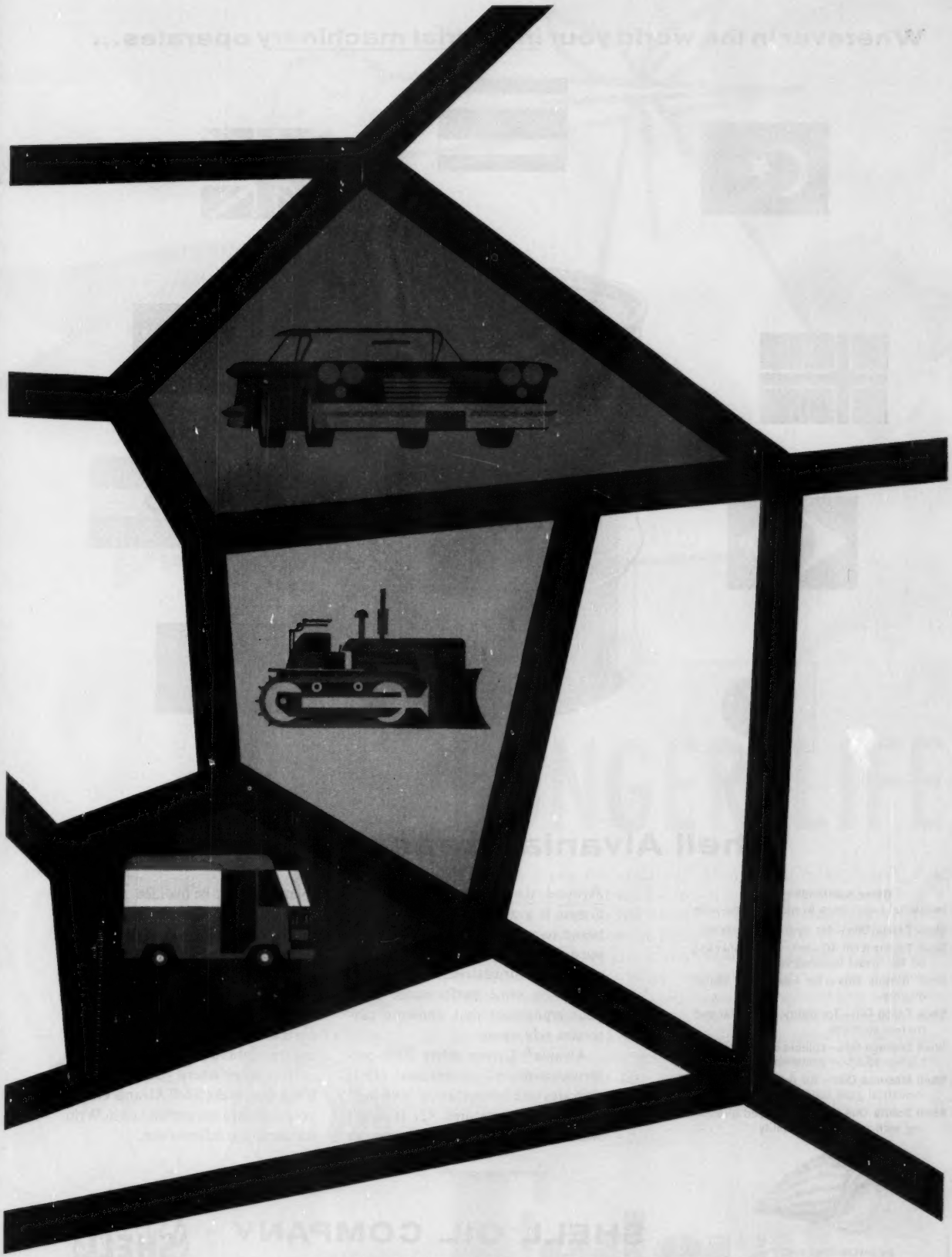
A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan

Steel

Look for the STEELMARK on the products you buy; place it on the products you sell.



Great Lakes Steel is a Division of **NATIONAL STEEL CORPORATION**

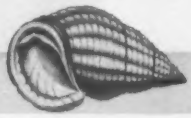
Circle 459 on Page 19

Wherever in the world your industrial machinery operates...

Shell Alvania Grease is there

Other outstanding Shell Industrial Lubricants available world-wide

- **Shell Tellus Oils**—for hydraulic systems
- **Shell Talona R Oil 40**—anti-wear crankcase oil for diesel locomotives
- **Shell Rimula Oils**—for heavy-duty diesel engines
- **Shell Turbo Oils**—for utility, industrial and marine turbines
- **Shell Dromus Oils**—soluble cutting oils for high-production metalworking
- **Shell Macoma Oils**—for extreme pressure industrial gear lubrication
- **Shell Voluta Oils**—for high-speed quenching with maximum stability



AN INTERESTING FACT!
Every Shell Branded Industrial Lubricant is named for a sea shell. Shown here is the Alvania beanii.

Around the world, Shell Alvania Grease is available—under the same brand name and providing the same outstanding lubrication. This is assurance that your customers abroad will enjoy the same performance from your equipment that domestic customers rely upon.

Alvania® Grease offers these performance-proved advantages: (1) It provides safe lubrication at both high and low temperatures. (2) It won't wash out even in locations where water splashing can't be avoided. (3) It has built-in protection against rust and pitting of anti-friction bearings. And because this *one* multi-purpose grease is specially designed to satisfy as much as 90% of industrial grease needs, less servicing time is required; inventory costs are less; and there is less risk of misapplication.

No matter where your machinery is shipped, make Shell Alvania Grease your standard recommendation. Write for complete information.

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Circle 461 on Page 19→

LONGER LIFE

We can tell you the exact day when a particular Federal Ball Bearing is born. But the day when it turns its last revolution is generally far, far in the distant future. Building long life into bearings is no accident at Federal. It starts with the long-lived SAE 52100 steel we use. It continues through the scores of production and quality control steps along the way. And when a Federal Ball Bearing is finally boxed for shipment, it has a life expectancy that should please the most hardened purchasing agent. In fact, we are on amiable terms with many who represent America's top manufacturers. To understand why they like us, start by sending for our catalog.

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FEDERAL ON FILM—A 16 mm. color sound film takes you through our 400,000 sq. ft. plant. Loaned free. Just ask for it.

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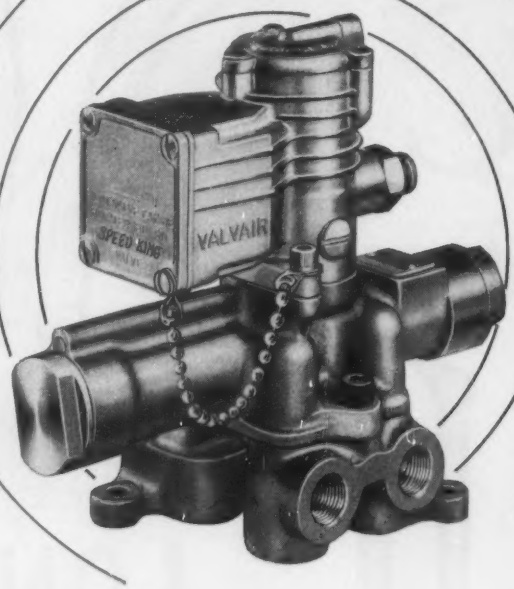
BALL BEARINGS

One of America's Largest Ball Bearing Manufacturers

No coil burnout with SPEED KING®



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• Built to JIC standards • interchangeable pilots • choice of mounting types, optional features • ac or dc, any voltage • ¼ to 1 in. NPT

SPEED KING solenoid pilot coils, potted in molded resin, are unconditionally guaranteed against coil burnout for the life of the valve! And, Speed King pilots are totally enclosed, and sealed against entrance of dirt or moisture . . . valves are fully air-operated for speed and dependability . . . feature a hard-chrome plated stainless steel plunger floating in O-rings, to eliminate wear-producing metal-to-metal contact.

For multi-million cycle dependability, specify Valvair® SPEED KING control valves.

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Write for free Bulletin SK-100. Address: Bellows-Valvair, Akron 9, Ohio, Dept. MD-1160.

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (iBEC)

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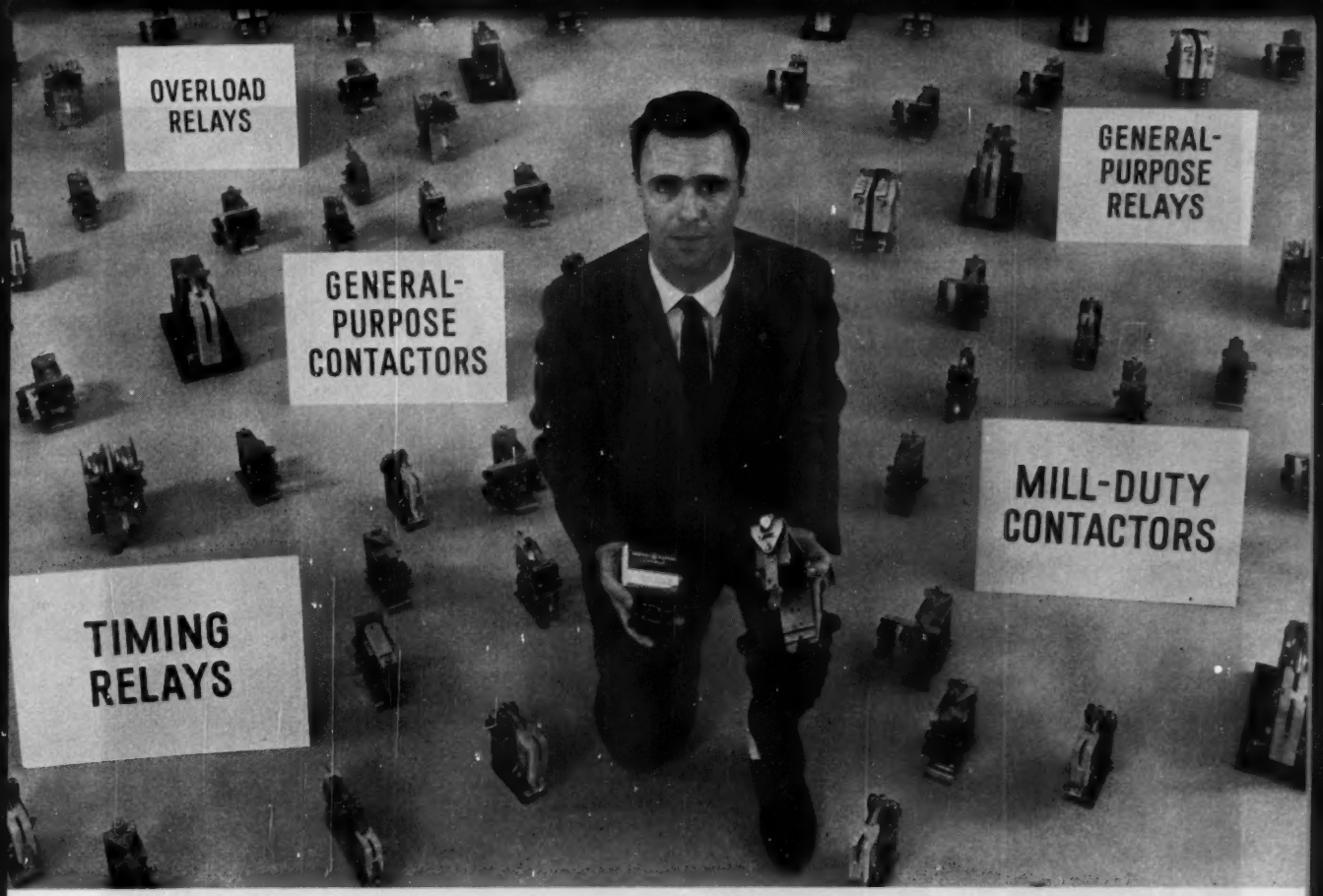


GENERAL ELECTRIC DC CONTACTORS AND RELAYS

Over 100 devices – available when you need them

Now . . . you don't need to wait for delivery of a particular contactor or relay . . . or to carry a large inventory . . . just to be sure you have the correct device for a job. With General Electric's new d-c contactors and relays—featuring "building-block" design—you assemble the device you want . . . when you ***need*** it . . . from standard components right in your own plant. More than a hundred different devices can be assembled from a parts stock of as few as a dozen General Electric "building-block" components!

This amazing versatility means ***immediate availability*** of any General Electric device. A "universal" contact block is the building unit for all types of contactors and relays. Choice of the frame-and-coil assembly and standard assembly kit permits variation in devices to meet your specific application.

Three types of contactors and six types of relays—for general purpose, mill-duty, overload and timing applications—can be assembled using this unique, cost-saving approach.

NEED OTHER COMPONENTS?

General Electric also has complete lines of plate rheostats and resistors for all your control needs. For more information, contact your General Electric Sales Representative or mail this coupon today! *Industry Control Department, Salem, Virginia.*

GENERAL ELECTRIC

Circle 463 on Page 19

Resistors—vitreous-enameled and wire- and ribbon-wound types from 5 to 1210 watts. Fixed, slide-wire, or tapped types available.

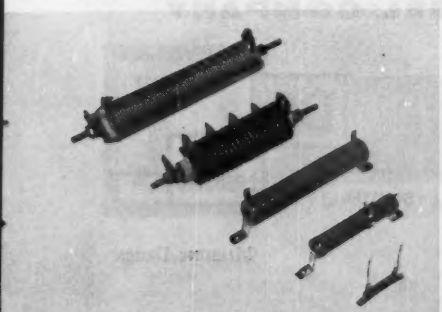
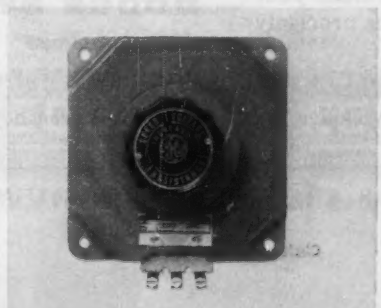


Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.



To: Section E784-26
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6621—D-c contactors and relays
- ☐ GEA-6592—Resistors
- ☐ GEA-6474—Plate-type field rheostats

Name_____

Company_____

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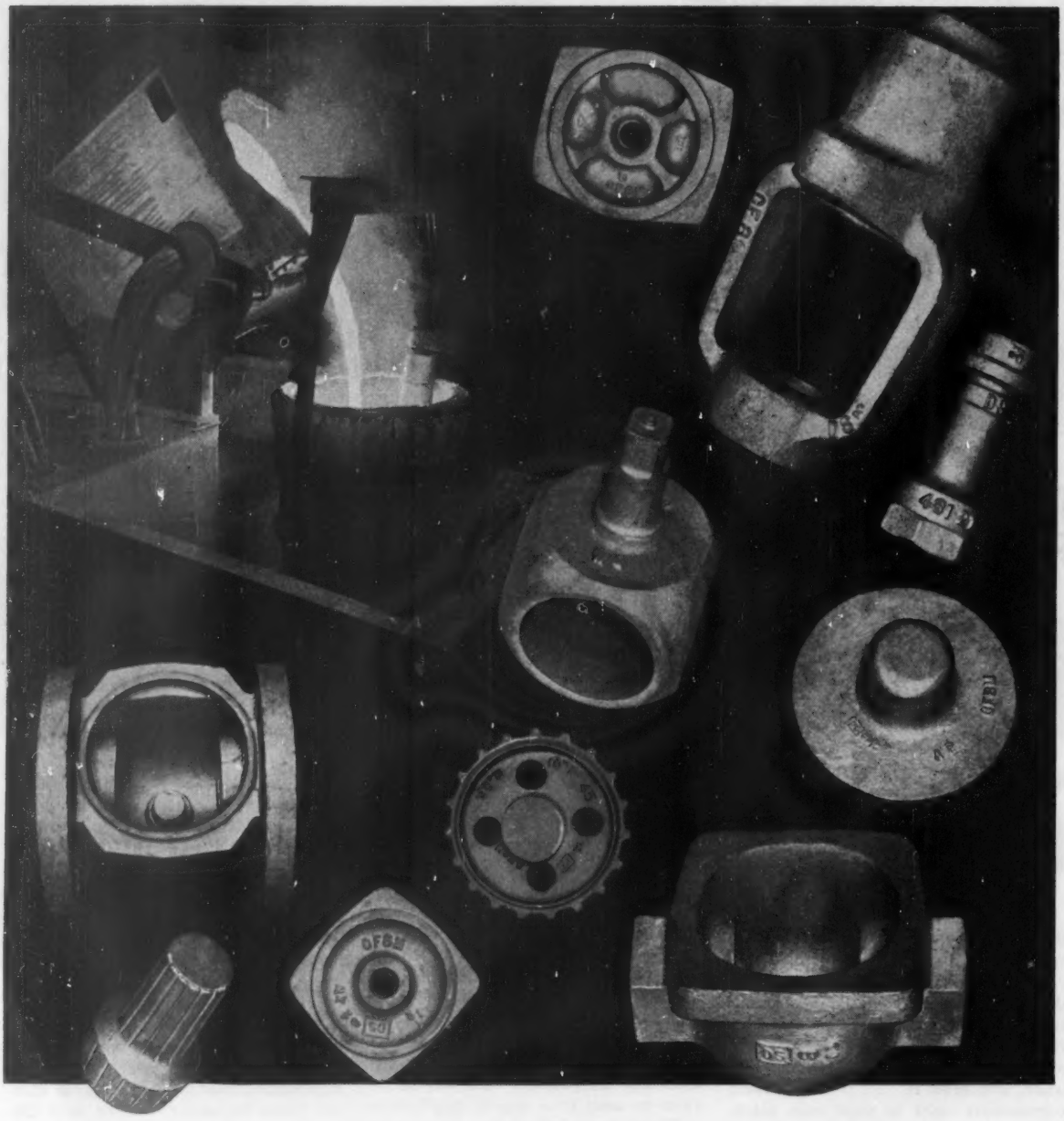
City_____

State_____



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The design and manufacture of quality stainless steel castings is a specialized job . . . *and Dodge specializes in it!*

There is practically no limit to the variety of shapes we can turn out to meet your simple or intricate specifications precisely . . . economically.

Perhaps one or more DS castings shown here will help spark an idea of how Dodge can be of assistance for *your* stainless steel casting needs. A blueprint or sketch with operational details will bring complete information, without obligation.

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NEW from Square D...

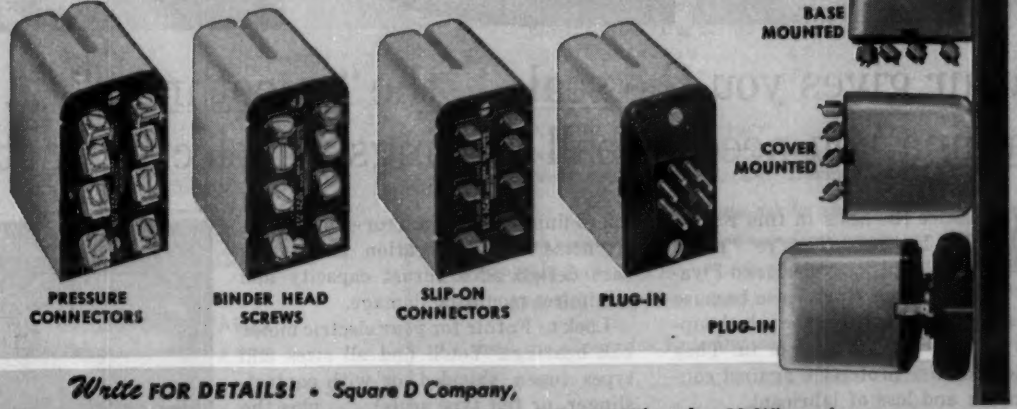
A SMALLER 10 AMP RELAY— WITH INDUSTRIAL FEATURES!

Actual Size
Type FO Relay (cover removed)

Terminal or Plug-In Wiring

- **RATINGS** easily handle solenoid loads. AC pilot duty rated 690 VA. Continuous rating 10 amperes, 125 volts AC for plug-in construction and 277 volts AC for terminal connection
- **Long Life** makes suitable for rugged machine tool applications
- **Molded coil** operates cooler and keeps out moisture for longer life
- **No solder joints** to break
- **Optional pilot light** indicates when relay is energized
- **Durable nylon dust cover** won't break, crack or support combustion

ALL THESE VARIATIONS OF WIRING AND MOUNTING

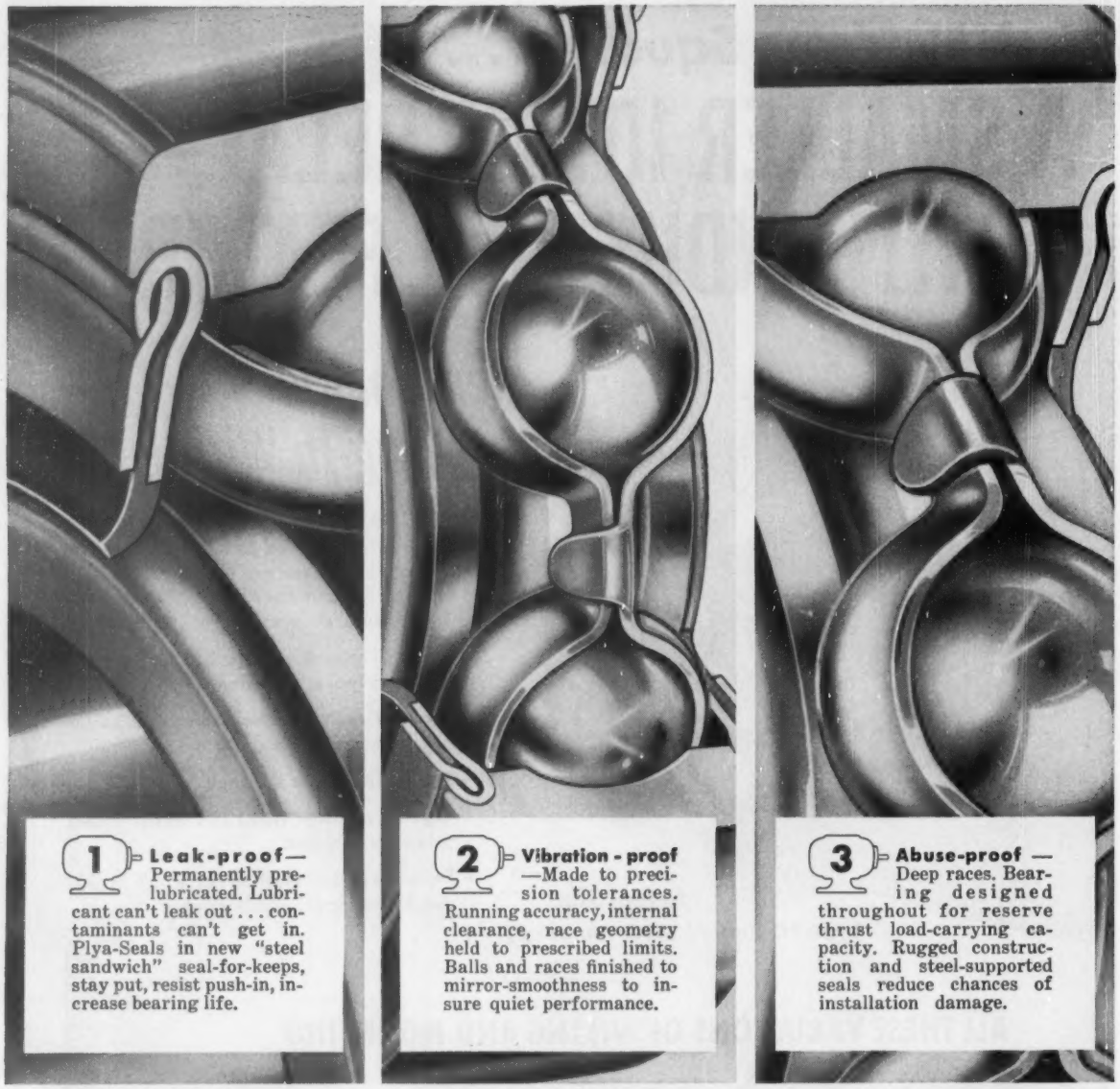


Write **FOR DETAILS!** • *Square D Company, Dept. SA, 4041 North Richards Street, Milwaukee 12, Wisconsin*

SQUARE D COMPANY

wherever electricity is distributed and controlled

Circle 465 on Page 19



1 **Leak-proof**—Permanently prelubricated. Lubricant can't leak out . . . contaminants can't get in. Plya-Seals in new "steel sandwich" seal-for-keeps, stay put, resist push-in, increase bearing life.

2 **Vibration-proof**—Made to precision tolerances. Running accuracy, internal clearance, race geometry held to prescribed limits. Balls and races finished to mirror-smoothness to insure quiet performance.

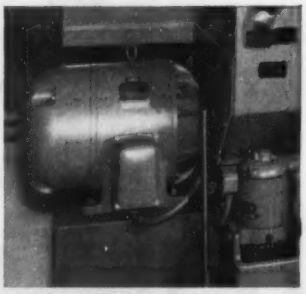
3 **Abuse-proof**—Deep races. Bearing designed throughout for reserve thrust load-carrying capacity. Rugged construction and steel-supported seals reduce chances of installation damage.

Fafnir gives you the seal . . . the "smoothness" . . . the stamina you need in ball bearings for electric motors!

Notice the seals in this Fafnir ball bearing. They're "rolled in". These newly designed Plya-Seals won't work loose because they are gripped between two steel supports . . . nor will they push in. They provide positive protection against contaminants and loss of lubricant.

You also get whisper-quiet performance. Balls and races in Fafnir precision ball bearings for electric motors are micro-finished to mirror-smoothness. No noise . . . no vibration. Extra-deep race design adds thrust capacity and minimizes mounting damage.

Look to Fafnir for *your* electric motor ball bearings. You'll find all sizes and types (open, shielded, or with contact, slinger, or felt type seals) . . . plus the capacity and uniformly high quality to meet your needs precisely. The Fafnir Bearing Company, New Britain, Conn.



Over 5000 electric motors in Fafnir's six plants including these 10 HP and ⅓ HP units, offer on-the-spot proving-grounds for electric motor bearing designs.

FAFNIR
BALL BEARINGS

Circle 466 on Page 19

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"Service Life Increased 600% with URETHANE ELASTOMER parts"

says James R. Hodde, Sales Engineer
Crutcher-Rolfs-Cummings, Inc.

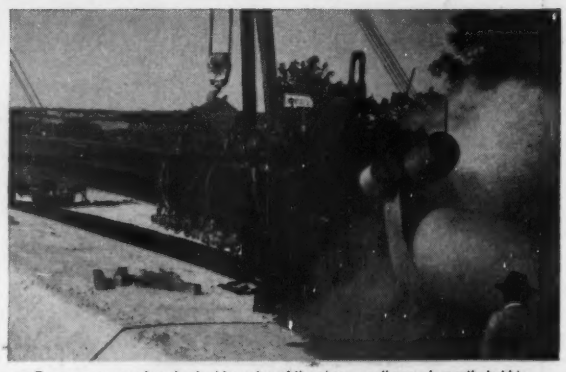
MULTRATHANE® CASE HISTORY NO. E-6.

"One of the most brutal tests for any material are the crawler wheels of equipment for cleaning, priming, coating and wrapping pipelines ranging from 2" to 36" in diameter," says Mr. Hodde. "Weights of our line travel equipment range up to 9,050 pounds for a 36" capacity unit. The crawler wheel inserts, leveled at a 27" angle, and mounted in pairs, must support the entire weight of the machine plus operator, fuel and materials as it travels along the pipeline doing its job.

"Fiber inserts formerly used lasted for only 10 or 12 miles of travel before they were worn so concave their steel flanges began scoring the pipe. Changing the inserts takes 3 to 4 hours with two skilled mechanics. In this time, 40% of the day's production could be lost.

"So dramatic has been the performance of urethane elastomer crawler wheel inserts that they have been standardized on all new equipment at our company, supplied to our specifications by the Acushnet Process Company, New Bedford, Mass. and Fort Worth, Texas."

This direct case history report from this heavy equipment manufacturer is typical of many others, testifying to the impressive savings in both maintenance and operation costs resulting from urethane elastomer's resistance to wear, abrasion and impact. Write Mobay for complete data on urethane elastomers made with Multrathane® chemicals, showing how you can put this "work-horse" material to work for you.



Two or more crawler wheels ride on top of the pipe as well as underneath, held in contact by spring loaded arms to insure adequate traction and prevent slippage.

MOBAY CHEMICAL COMPANY
Dept. n-c Pittsburgh 5, Pennsylvania

Mobay supplies Multrathane quality chemicals and technology for manufacturing urethane elastomers.

MOBAY
First in Urethane Chemistry

Right to a thousandth when you adjust with LAMINUM®

Just *p-e-e-l* the laminations—it's that easy to get accurate assemblies with LAMINUM . . . even as close as a thousandth. No machining. No grinding. No counting. No stacking. No miking. And no need for stand-by equipment.

LAMINUM is versatile, too. You have a choice of brass, mild steel, stainless or aluminum . . . of .002″ or .003″ laminations . . . of plastic bond or metallic bond.

Whatever your choice, we'll custom-stamp LAMINUM to your own rigid specifications . . . any size, any shape, and quantity . . . to look and act like solid metal . . . to help you produce more and better assemblies . . . in less time . . . and at less cost.

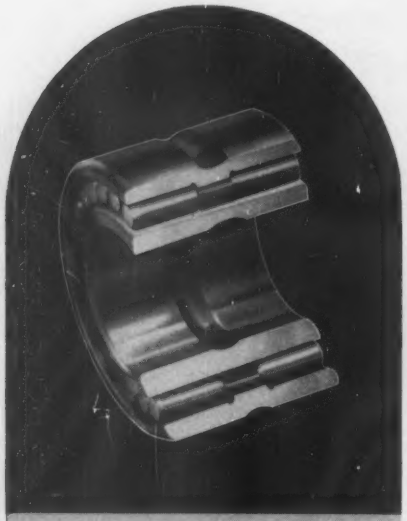
That's what makes LAMINUM so practical. So popular. So easy to use. Revised SHIM DESIGN FOLDER No. 4 gives complete up-to-the-minute engineering data. Send for your copy today.

THE LAMINATED SHIM COMPANY, INC.
Home Office and Plant
1211 Union St., Glenbrook, Conn.

•

West Coast Sales and Service
600 Sixteenth St., Oakland 12, Calif.

Circle 469 on Page 19



McGILL® GUIDEROL® BEARINGS
pack more capacity in less space

- *Center-guided rollers limit skewing tendency, prevent binding*
- *Integral seals increase life — avoid frequent relubrication*

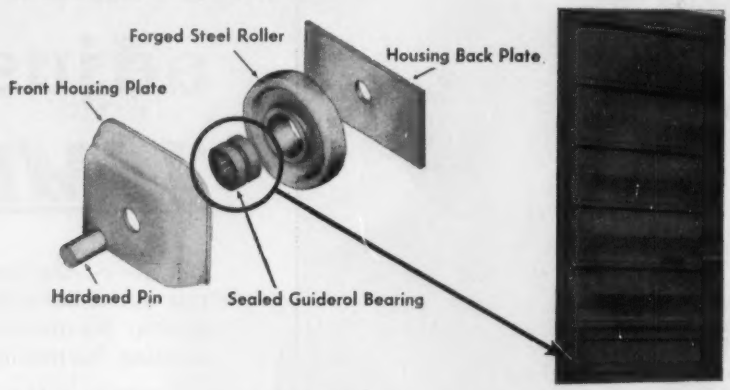
GUIDEROL bearings provide the maximum load carrying surface and minimum radial dimension advantages of full-type roller bearings — plus free and accurate tracking where misalignment is controlled. They are especially suited to vertical mounting. Sealed models keep out abrasive and lube-diluting contaminants — and avoid relubrication problems. These heavy duty units are available with or without inner races with bore sizes from ½" to 9¼". Typical applications and their advantages are shown below.

Integral seals protect operation of GUIDEROL® bearings in PULLMAN-STANDARD box car door rollers

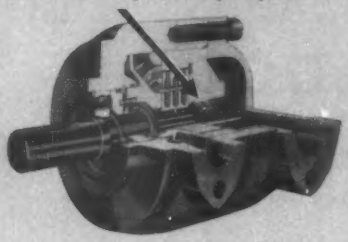
Pre-lubricated and sealed GUIDEROL bearings are used in the door roller assembly shown here by the Pullman-Standard Car Manufacturing Company to assure ease of operation in spite of exposure to severe service conditions. Integral seals prevent infiltration of dirt and retain lubrication thus minimizing maintenance.

This roller arrangement was proved through test-application of over 75,000 severe individual roller and bearing impacts. Normal operation imposes loads of 600 pounds at 1.5 G's vertical acceleration.

Pullman-Standard also uses McGILL sealed GUIDEROL bearings in their P-S Compartmentizers, which consist of two pairs of strong steel gates dividing the box car interior into three flexible-size compartments. The gates roll smoothly on GUIDEROL bearing equipped rollers for easy, quick, one-man operation.



GUIDEROL® compactness and high load capacity utilized in DENISON hydraulic pumps



The Denison Engineering Division of American Brake Shoe Company cites compactness, high load capacity and separable design as advantages of the McGILL GUIDEROL bearings which they use to carry externally applied loads in their "T" Series Balanced Vane Hydraulic pumps. Denison Engineering also state that they have benefited from "Good delivery and cooperation from McGILL Engineering on new development."

Typical applications of Denison "T" Series Balanced Vane Pumps are for continuous 2000 psi service in earthmoving equipment, and similar types of mobile equipment; special machinery, such as extrusion presses and in automation feed service and index mechanisms.

OLIVER tractors use GUIDEROL® bearings to provide long life

The Oliver Corporation employs a McGILL GUIDEROL bearing as the rear support for the power take-off shaft of its 660, 770 and 880 model tractors. The application is unusually demanding because of high fluctuating loads which may be applied by universal joints employed at an excessive angle, or by vee-belt or chain sprocket accessory drives. Oliver says the McGILL GUIDEROL has "long life, requires little maintenance, and will accept great loads." It operates at 540 rpm at a theoretical loading of 366 lbs. — greatly magnified by varying PTO attachments.

engineered electrical products

McGILL®

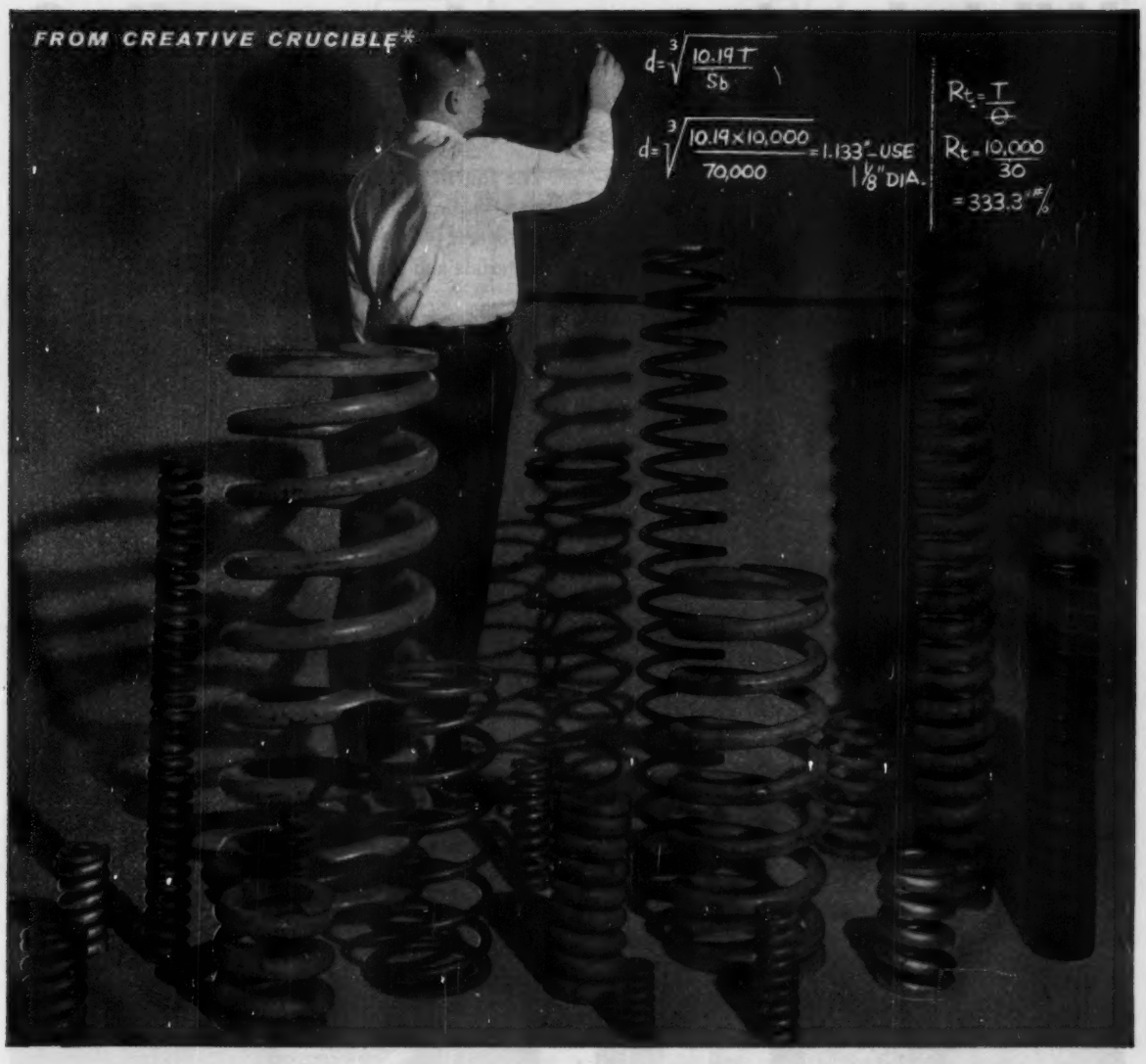
precision needle roller bearings

Send for free copy of McGILL Bearing Catalog No. 52-A.

MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING CO., INC., Bearing Division
200 N. Lafayette St., Valparaiso, Indiana

Circle 470 on Page 19



Any one of these fatigue-resistant springs will outlast a conventional spring

Yet all of them are competitively priced! Size for size, these heavy-duty, hot-wound springs withstand heavy compressive, tensile or torsional loads—throughout longer periods of service.

Shot peening accounts for the springs' increased endurance. Shot peening imposes a compressive stress on the surface that offsets stresses set up in service. It also "conditions" the surface and eliminates stress concentration points that could lead to premature failure in a conventional spring.

Design Handbook On Coil Springs
But read how you can save space and cut costs with fatigue-resistant springs (the product of Crucible metallurgy from ore to finished spring). Write for the *Heavy Duty Coil Springs* handbook to *Crucible Steel Company of America, Spring Division, Dept. GK07, McCandless Avenue, Pittsburgh 1, Pennsylvania.*

***HEAVY-DUTY HOT-WOUND COIL SPRINGS** — Crucible makes fatigue-resistant and conventional springs of carbon, alloy, and specialty steels in a wide variety of treatments, from ½" bar size up. Both types are now being used in countless applications in missile launching equipment, freight cars, mining and earth-moving equipment.

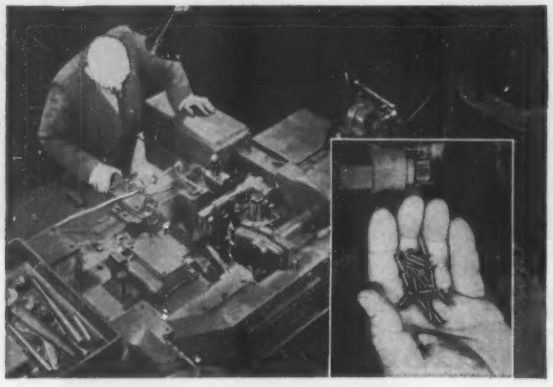
CRUCIBLE HEAVY-DUTY COIL SPRINGS

Which picture do you fit?

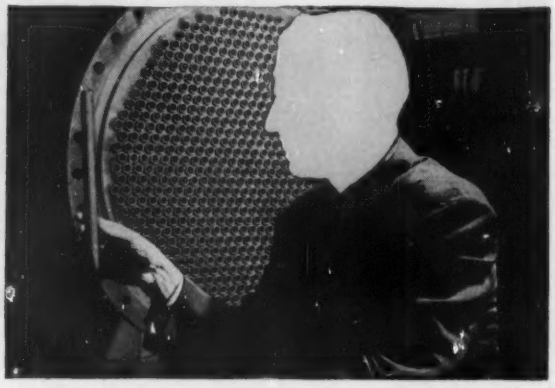
Here are four *actual* customers* with different, but exacting product and technical needs. One uses Bridgeport rod in a range of alloys, the second Bridgeport strip. A third makes fasteners from Bridgeport Brass wire. The fourth company uses Bridgeport condenser tubes *and* Technical Service to produce quality heat exchangers. Which picture do you fit with your raw materials and manufacturing requirements?

"AUTOMATIC QUALITY," says Customer A. "We've a high-volume, automatic screw machine operation. Our alloy needs vary from job to job. Our production schedules demand *consistent* quality alloy and accurate gauge. With every rod alloy we get from Bridgeport, we get what we order . . . including aluminum alloys!"

"LONG-LENGTH COILS. They're one reason why we can depend on Bridgeport for strip," says Customer B. "Superior surface finish from Bridgeport saves us production costs. With their Sendzimir mill finish and exact gauge and width in long-length coil, you can see the reasons why we depend on Bridgeport for brass, copper and aluminum strip."



"CONSISTENT GAUGE. We need Bridgeport quality brass wire to make thousands and thousands of fasteners of every description," says Customer C. "High-speed, volume cold-heading production is only as good as the alloy wire that's used. Bridgeport Brass wire is made to exact tolerances for cold-heading at high speeds—we depend on it."



"PRODUCT PLUS SERVICE," says Customer D. "We manufacture heat exchangers for many applications. Our requirements include good technical and engineering service as well as a wide choice of brass, copper and aluminum tube alloys. All of these are available from Bridgeport."

*Names on request

These examples typify national metalworking opinions. There's no mystery why manufacturers the country over depend on Bridgeport—Bridgeport products and service are *close at hand*. The many brass, copper and aluminum alloys made by Bridgeport in rod, tube, wire and strip are *readily* available from stocks in your area; Bridgeport warehouses are located to make it easy for you to get what you want on time. Volume needs are mill-delivered. Your call to your nearest Bridgeport Sales Office, or a letter to Dept. 8911 will get you engineering and technical service. Try it, and you'll agree —you do fit into the picture!

Bridgeport Brass Co.

BRIDGEPORT BRASS COMPANY

Bridgeport 2, Conn. • Sales Offices in Principal Cities

Specialists in Metals from Aluminum to Zirconium

HOKE Flow Sheet 2

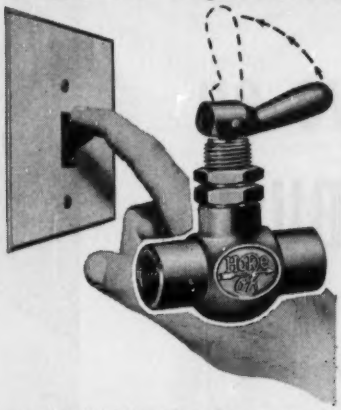
HOKE REPORTS ON FLUID CONTROL

WE'VE PACKED PERFORMANCE IN A PACKLESS VALVE

How to be "Flip" About On-Off Control

We've turned the tables on electrical engineering profs who try to demonstrate current flow by describing a valve on a pipe. Our switch-action toggle valves stop and start flow just as easy as: Flip, it's on! — Flip, it's off!

These valves perform a basically simple function, but a lot of engineering went into them to insure perfect performance. Many are used on precision test equipment and for control applications, often in conjunction with automatic controls as a manual safeguard for fast shut-off. Designed for both



gas and liquid service, the stem seals are tight enough for most vacuum work, too. We certainly can't be flip about these specifications.

Hoke manufactures two types of toggle valves. The 450 Series has maximum operating pressures up to 200 psi. These are spring closing valves made in ¼" and ⅛" pipe sizes which can be classified as "miniatures", measuring less than 2" in height in the closed position. They are normally supplied with moulded, black, Nylon handles, but colored handles can be supplied for special identification purposes. Panel mounting lock-nuts are included as standard equipment on every valve.

The second type is the 490 Series, a cam-closing toggle valve for service up to 2000 psi. They'll give you the same quick, positive action as the 450 Series, while performing the toughest laboratory and process jobs. The 490 and the 450 are excellent performers on non-critical high vacuum. They can be helium leak-tested for this purpose.

So, if you're interested in switch-action flow control, investigate the Hoke toggle valves. We'll be happy to equip you with complete technical data. A check in the coupon to the right will bring you the facts.

The development of packless valves has so greatly reduced the problems of handling high pressures, temperatures and vacuums, and dangerous fluids that engineers designing such systems can now spend more time curled up with the Hoke Corrosion Chart.*

With this extra time, many have dreamed up weird applications for the Hoke 440 Series bellows seal valve, trying to snare us in our own semantics. In a rash moment, we boasted that this valve could be modified for almost any application. Actually, the 440 can be modified to work at high pressures (up to 2000 psi), for high temperatures (up to 1000°F.), and for special connections such as tubing, socket welding, and silver brazing.

Aside from this horn-blowing, here are the dry facts. The basic design includes a stainless steel body, inert arc-welded bellows assembly, Teflon gaskets and Teflon stem point discs. This is only the starting point. Minor modifications make so many models available that almost any problem, including liquid metal handling, can be solved.

Hear what a disbeliever said: "I did not believe that the modified valves would satisfy all my requirements, especially to keep a high vacuum of the order of 10^{-8} mmHg under a wide variation of temperatures; however, I now acknowledge that the modified Hoke 440 valves fulfilled their duty perfectly." This came from The Martin Company, where we sent 440's for use in cesium vapor up to 400°F. Special

The cesium boiler shown above uses a modified version of the Hoke 440 series bellows seal valve (at right) to handle high vacuum of 10^{-8} mmHg and cesium vapor at tematures up to 400° F.

modifications made these valves readily usable on a cesium boiler and converted an infidel to the true valve.

If you work with critical high vacuum, high pressures, high temperatures and dangerous fluids, proceed with care. Ask for our Packless Valve Bulletin to reap a harvest of engineering plums.

** Makes good reading if you're handling corrosive agents. Write, and we'll send you one.*

FREE! A STEADY FLOW OF FACTS!

Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

Hoke's Performance Guarantee — *Every Valve Leak-Tested!*

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91 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

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- ☐ Toggle Valves
- ☐ Flow Sheet
- ☐ FREE Corrosion Slide Rule
- ☐ Complete Catalog GC 959

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COMPANY _____

ADDRESS _____

CITY _____ STATE _____

Circle 473 on Page 19

Motors Thrive on FREQUENT OVERLOAD ABUSE!

***Brunswick* D-31 Precision Bowling Lane Sanders**

Powered by Lightweight R&M 8 HP Single Phase Motors

The Brunswick-Balke-Collender Company recently handed ROBBINS & MYERS an unusual motor problem when it re-powered the Brunswick D-31 precision bowling lane sander. The D-31 cuts across 250 square inches of area in one continuous cutting operation. Motor must withstand frequent and severe overloads when the machine levels high spots in the alley bed. Power had to be single-phase, too, because many bowling establishments carry only single phase current! To keep sander truly portable and easily maneuverable . . . and to protect lanes from excess weight, motor had to be lighter than ordinary single-phase motors.

ROBBINS & MYERS custom-designed an 8 HP capacitor-start, capacitor-run motor that is daily proving its stamina against these rugged requirements. Should more power be needed, design includes provision for adding an auxiliary blower which can conveniently increase capacity to 10 HP. Weight was kept down by using special aluminum end heads. For easier maintenance, the extended end-head housing can be removed quickly and easily to expose condensers and centrifugal switch.

Many other features insure longer life for *every* R&M motor: double width bearings that have extra-large grease capacity . . . Mylar* insulation with 8 times the dielectric strength and 35 times more moisture resistance than ordinary paper insulation . . . removable caps for quick bearing inspection and relubrication . . . end heads that give full-height protection . . . dual-sweep ventilation for efficient cooling.

For motors to meet unusual challenges . . . and for standard motors, always contact ROBBINS & MYERS! Write today for Bulletin 470-MD

**DuPont registered trademark*

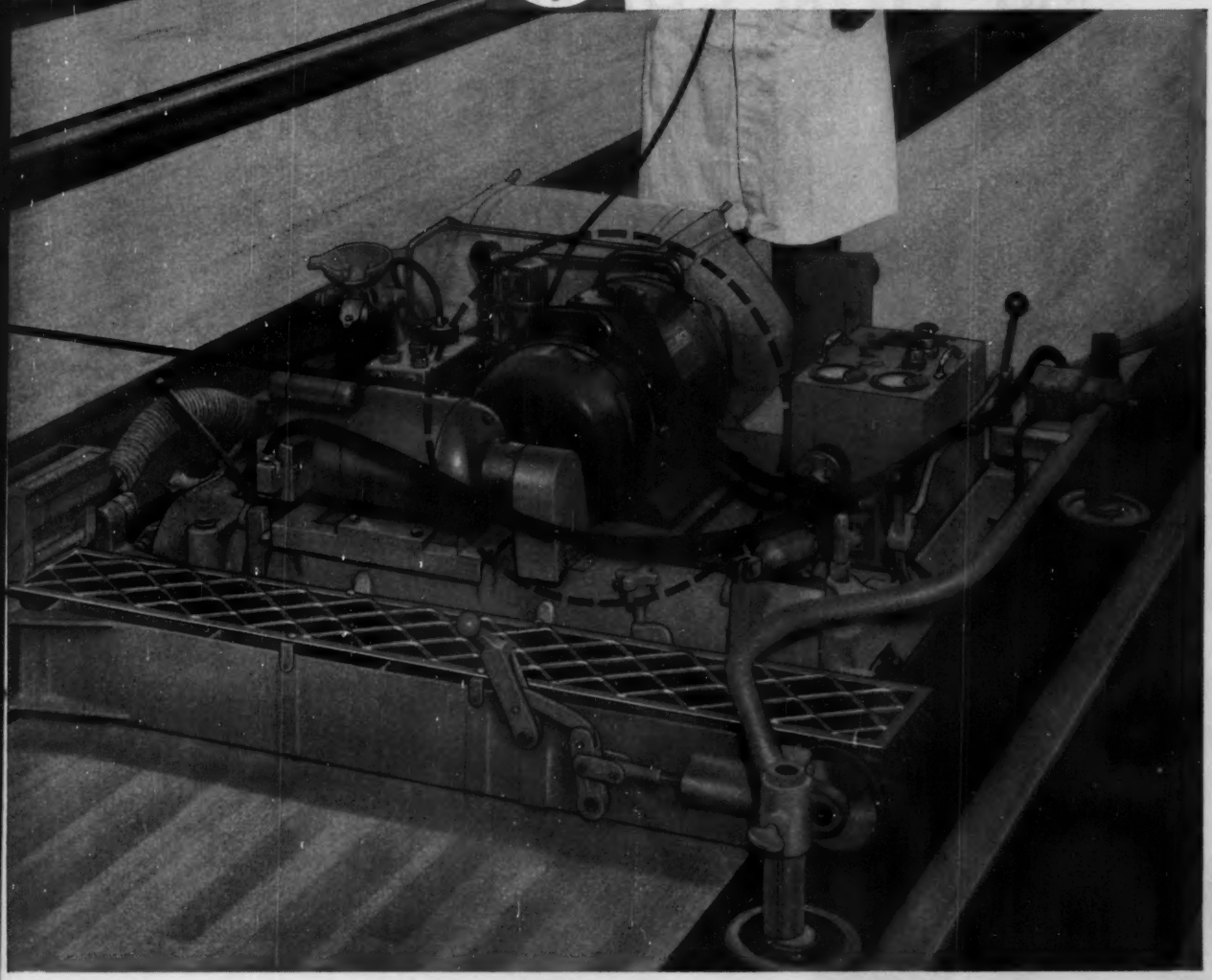
ROBBINS & MYERS, INC.

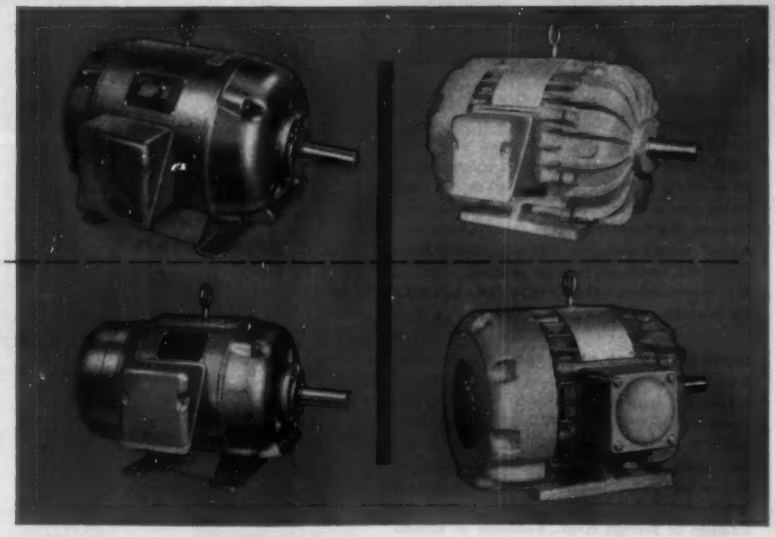
motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

MOTORS 1 thru 200 HP

(other ratings 1/200 to 1 horsepower)





Open Protected Motors (left), up to 200 HP, are suitable for many applications formerly requiring totally enclosed construction.

Totally Enclosed Motors (right), ½ to 200 HP, are fan-cooled . . . offer complete protection against all harmful atmospheres.

"PM" Single Phase Motors (left), ratings through 20 HP, eliminate maintenance because they are fully weatherized for severe duty.

Explosion-Proof Motors (right), ratings through 200 HP, are Underwriters' Approved for Class I, Group D, and Class II, Groups F & G.

"ACTION FROM REPUBLIC SAVED US MONEY"

. . . John Whitman, Chief Engineer

How Republic metallurgists helped Applied Arts Corporation solve a difficult stainless steel forming problem

Applied Arts Corporation, Grand Rapids, Michigan, makes stainless steel trim for the automotive industry. For one 1960 model, they were under contract to produce window trim that was stamped rather than roll formed. The piece called for a particularly severe draw.

"We were getting a badly roped surface on this window trim," says Mr. John Whitman, Chief Engineer. "Republic field metallurgists were called in and went to work immediately. They camped in our plant and scrutinized forming operations: blanking, rough drawing, rough curling, cam flanging, finish curling, notching, and polishing. Then they met with their mill and laboratory metallurgists.

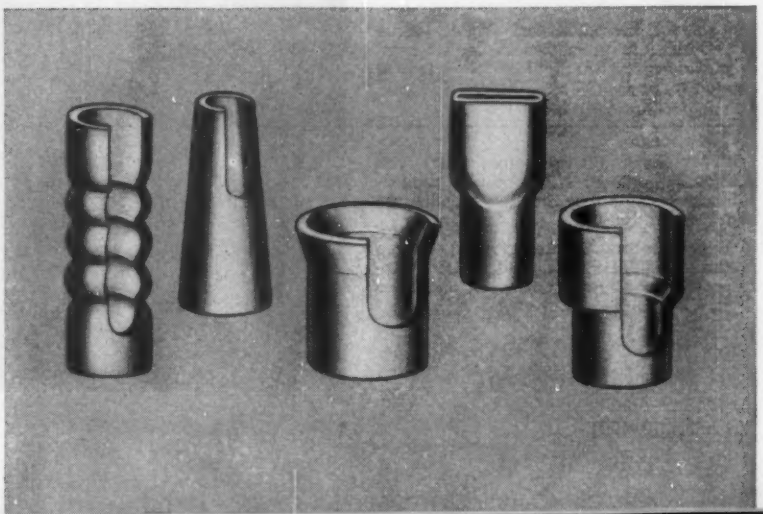
"The solution came fast. Republic metallurgists found that by slightly varying the physicals of the stainless (type 430), the breaking was eliminated. As a result, reject rate is now well below our original estimate. We have been able to stay with the same forming operations."

REPUBLIC STAINLESS STEEL METALLURGISTS will help you select, apply, and process the stainless steel—from our more than 40 standard types—best suited to your requirements. Write today or mail the coupon for information on this confidential, obligation-free service. *Circle 477 on Page 19*

VACUUM-MELTED METALS are produced by Republic in up to 20,000-pound heats. Available in billets, plates, sheets, bars, strip, and wire, these include: super alloy steels, constructional alloy steels, high strength alloy steels, bearing steels, special carbon steels, stainless steels, and titanium. The consistently high purity of vacuum-melted metals enhances mechanical properties—ductility, resistance to notch sensitivity, fatigue life, tensile strength, and others. Return coupon for information. *Circle 475 on Page 19*

SIMPLIFIED TUBULAR PARTS PRODUCTION results from the use of Republic ELECTRUNITE® Round Mechanical Tubing. With uniform wall thickness, concentricity, strength, and ductility, this tubing is easily flanged, swaged, flattened, spun, fluted, configured, rolled, upset, and otherwise changed in cross section. ELECTRUNITE is formed from highest quality flat rolled steel . . . welded without the addition of foreign metal. Available in carbon and stainless. Mail coupon for data.

Circle 476 on Page 19



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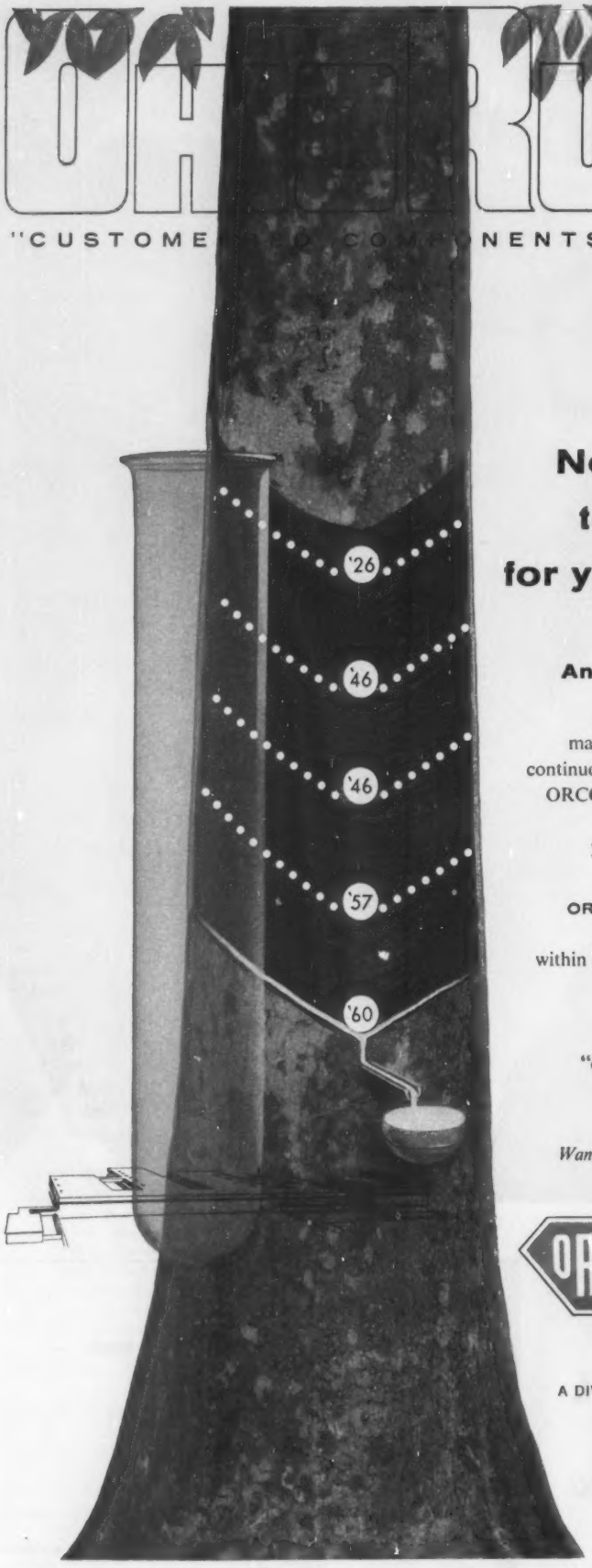
OHIO RUBBER

"CUSTOME[illegible] COMPONENTS BASIC TO INDUSTRY"



New plant growth to tap for your rubber needs

And you made it possible!

Ohio Rubber's history of plant growth and manufacturing expansion dates back to 1926—continues through 1946 and 1957. And, in late 1960, ORCO opens its new Fort Smith, Arkansas plant—dedicated, as with the others, to serve you better—to supply your increasing needs for custom components.

ORCO SUM TOTAL: 5 major, geographically strategic plants . . . 1,200,000 square feet within 143 acres . . . over 2000 trained employees . . . diverse products of natural and synthetic rubber, neoprene, polyurethane, flexible and rigid vinyl . . . "customer-friends" like you across the board in industry, nationwide.

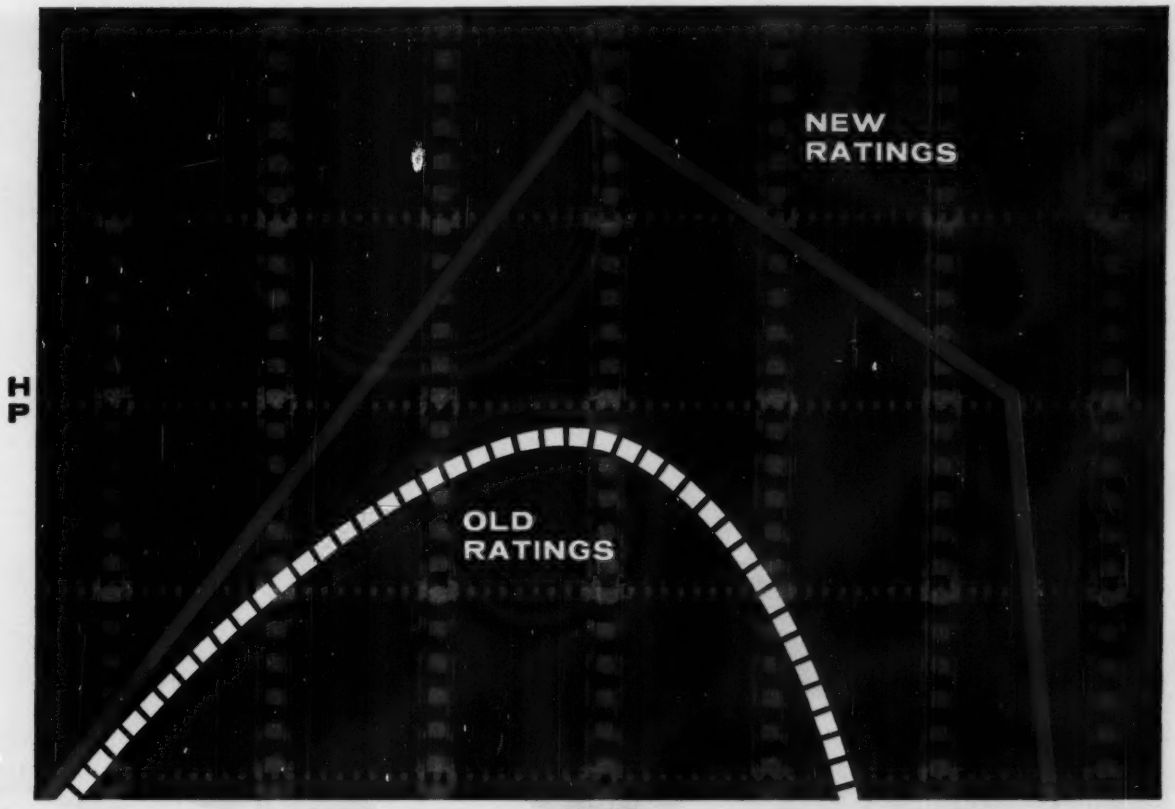
Want to know more about Ohio Rubber? Write today for our "Customeering" bulletin.

MP-260

ORCO THE OHIO RUBBER COMPANY

General Office • *Willoughby, Ohio* • WHitehall 2-0500

A DIVISION OF THE EAGLE-PICHER COMPANY



NEW HORSEPOWER RATINGS FOR REX ROLLER CHAIN

Break the Barriers on Speed and Capacity

Now you can use Rex Roller Chains for efficient operation at horsepower capacities and speeds generally considered impractical in the past. New ratings, made possible by quality improvement and proved in the most exhaustive laboratory and field tests, now open fields of application for the imaginative designer.

The new horsepower ratings were developed by the combined efforts of the Association of Roller and Silent Chain Manufacturers. Rex Engineers took an active part in this program. Here are the facts:

PRODUCT IMPROVEMENT PROGRAM

For some time, Rex Engineers have been engaged in a program of continuous product improvement. Such developments in design and manufacturing as guided piercing and re-piercing of link plate holes...precise control of pin, bushing and roller diameters...precision interference fits of pins and bushings in link plates...accurate control of pitch...oil holes in bushings for increased access of lubrication to live bearing areas...have resulted in greater horsepower capacity for Rex Roller Chains.

APPLICATION EVALUATION PROGRAM

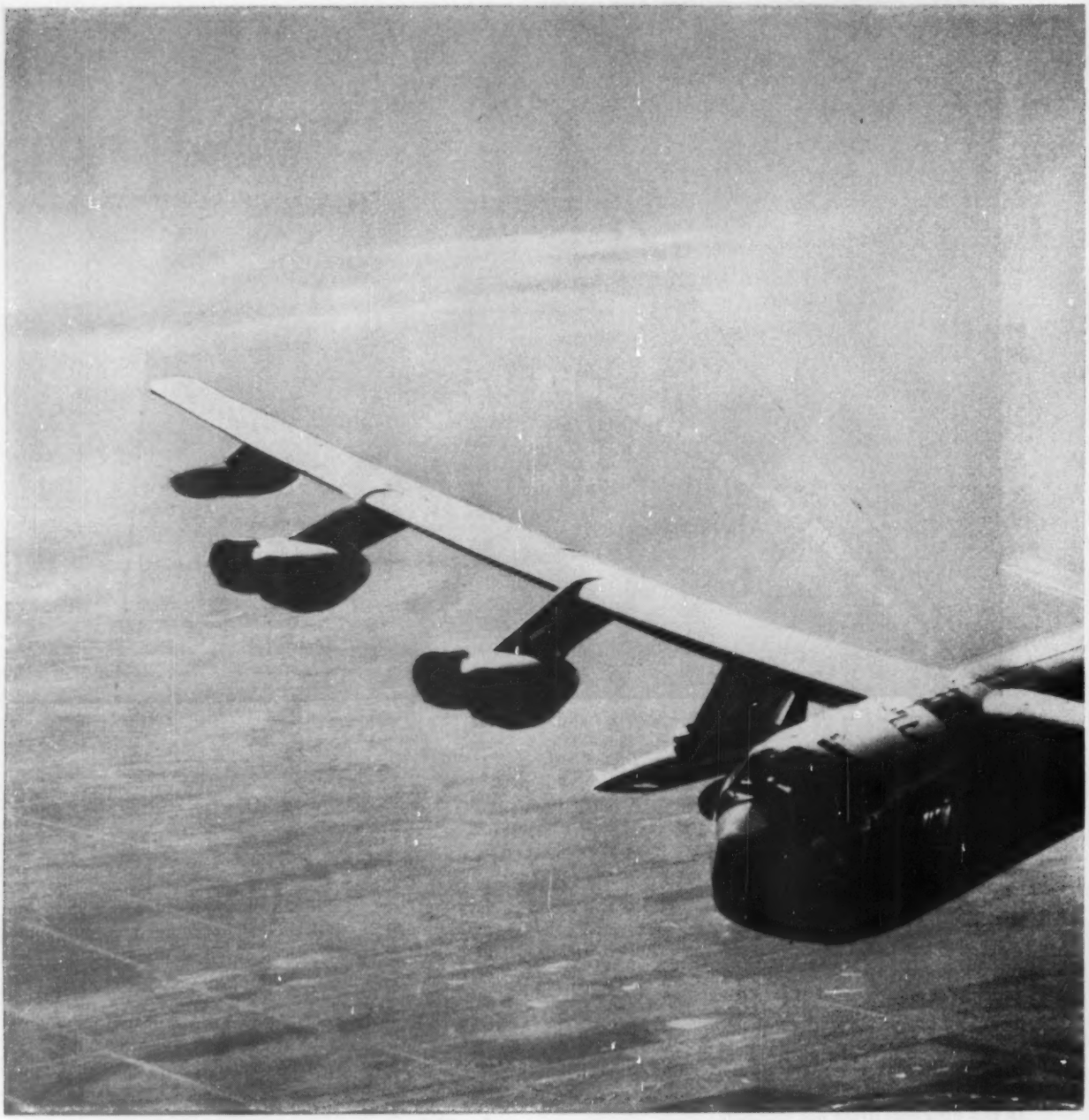
Through years of extensive work both in conjunction with the Association of Roller and Silent Chain Manufacturers, and in CHAIN Belt laboratories and in the field, Rex Engineers have helped acquire a more intimate knowledge of the load and speed requirements of roller chains under actual service conditions. Such testing programs as field dynamic load tests using strain gauges on actual operating chains...the relationship of proper lubrication and speed as it affects galling...have led to successful applications of Rex Roller Chains at greater loads and speeds than previously considered practical.

For all the facts and your copy of the new horsepower ratings, write CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave. East, Toronto.

REX®

CHAIN BELT COMPANY

Circle 479 on Page 19



The **BOEING** B-52G triple-threat nuclear bomber — a major weapon in the current SAC deterrent force—recently carried two big missiles over the North Pole on a 10,800-mile nonstop flight. The flight was another example of a successful effort by the SAC-industry team to provide constant refinement and maintenance of the Strategic Air Command's "big stick" fleet of heavy and medium jet bombers. Designed originally as a platform bomber, the B-52G can now carry, in addition to its bomb load, two North American "Hound Dog" GAM 77 missiles capable of tracking down targets hundreds of miles from their launching point. This makes it possible for the big ship to strike at three entirely separate targets in one raid. The B-52G transports a gross weight of nearly half a million pounds, and Alcoa® Extrusions help carry the load.

Now included in the main wing section are 75-ft extruded 7178-T6 Alcoa Aluminum alloy panels which make possible fuel storage in nearly the whole in-spar area (out to the external underwing fuel tanks). The external fuel tanks provide still additional range.

By shaving some 10,000 lb from the previous model, the B-52G range is increased by about 6 per cent . . . a weight saving accomplished mainly by a redesign of the wing structure. Boeing engineers greatly increased interior fuel storage, replaced fuel bags with an integral wing configuration.

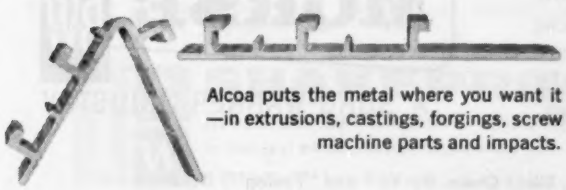
Alcoa Extrusions—in widths up to 35½ in.—are actually extruded for the B-52G in the "V" shape (pictured at right) on one of Alcoa's 14,000-ton extrusion presses. They are then cold rolled into the flattened cross section. The part is sent to Goodyear Aircraft Corporation, Litchfield Park, Ariz., for machining and assembling into a portion of the center wing section. Goodyear, in turn, ships the completed unit to Boeing Airplane Company, Wichita, Kan., for installation in the airplane. Extensive machining, riveting and assembly operations are eliminated by the use of these large extrusions—and the required strength is obtained with less weight than would be

HOW TO CARRY A "BIG STICK" 10,800 MILES!

necessary if the wide section were built up from smaller pieces.

Mammoth presses are only a part of the story. Complex auxiliary equipment, including a 120-ft-long stretcher (with 3,000,000-lb pulling force), roll straighteners and detwisters, enables Alcoa to extrude shapes that put the metal where it is wanted! With this extrusion equipment, Alcoa can produce closed-end containers up to 44 in. in diameter, stepped or other type extrusions up to 2,500 lb total weight, extrusions up to 39 in. in width, tubing of uniform or variable wall up to 19½ in. inside diameter. In addition to aircraft and other defense applications, large shapes extruded by Alcoa find uses in the electrical industry, pipelines, truck, bus, trailer, ship and architectural construction.

For more information, write Aluminum Company of America, 905-L Alcoa Bldg., Pittsburgh 19, Pa. World-wide sales through Alcoa International, Inc., 230 Park Avenue, New York 17, N.Y.



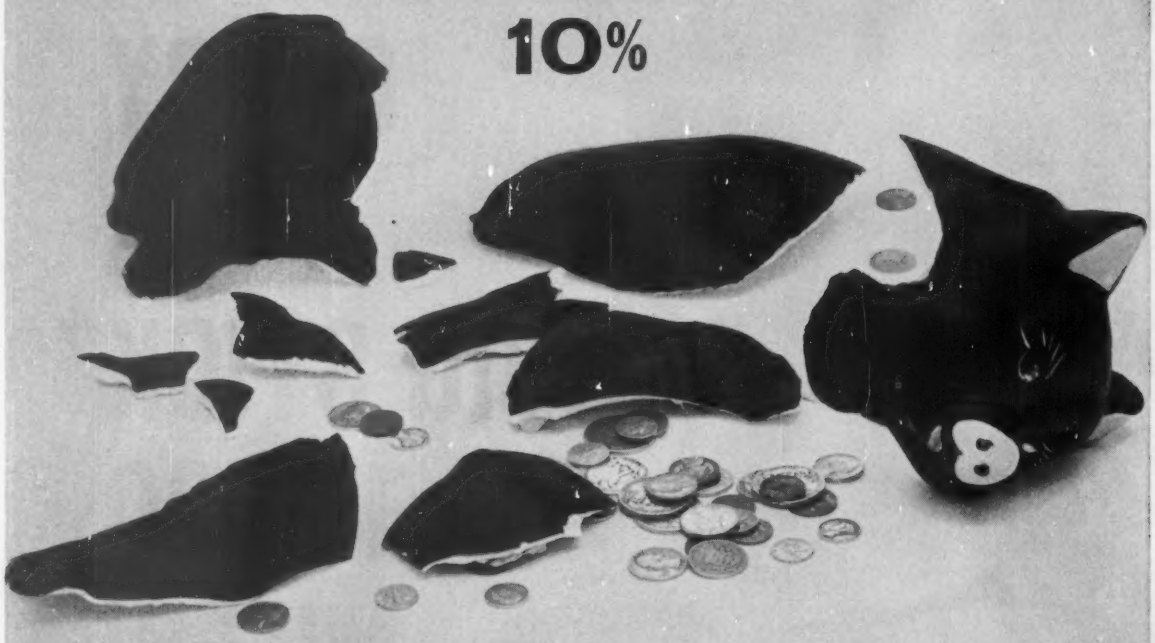
Alcoa puts the metal where you want it —in extrusions, castings, forgings, screw machine parts and impacts.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Circle 480 on Page 19

Would you spend an extra 10%



to double roller chain life?

Morse H-E Roller Chain overcomes metal fatigue . . .

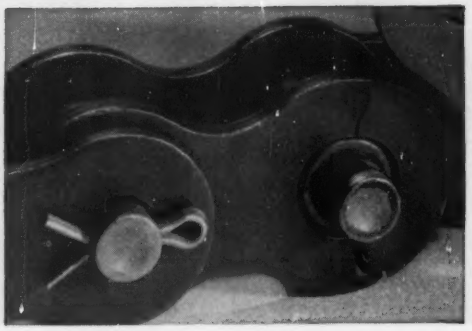
lasts from 2 to 5 times longer . . .

costs only 10 per cent more than ordinary roller chain!

Yes, now by paying just a slight premium you can buy Morse H-E (high endurance) roller chain . . . and get 2 to 5 times the service life over ordinary chain. Here's why:

Normal roller chain breaks sooner under the rigors of "stop-and-start" or heavy strain operations. It's this "tired metal" problem that plagues anyone who has used roller chain. Morse has developed a process to overcome metal fatigue. As a result, Morse H-E Roller Chain has a 95% greater endurance limit . . . lasts up to 500% longer . . . costs just 10% more.

Make a test yourself. Next time you need roller chain, try Morse H-E and compare. Your Morse Chain distributor is the man to see. He's listed in the Yellow Pages under "Power Transmission." Or write: Morse Chain Company, Dept. 6-110, Ithaca, N.Y. Export Sales: Borg-Warner International, Chicago 3, Ill. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.



ORDINARY CHAIN BREAKS when the side plate tires from repetitive loading and unloading during the cycle around the sprockets. But Morse H-E Roller Chain has a 95% higher endurance limit . . . outlasts ordinary chain by up to 5 to 1 under repeated loading.

MORSE B-W T.M.

A BORG-WARNER INDUSTRY

ONLY MORSE OFFERS ALL FOUR: Roller Chain, Silent Chain, Hy-Vo® and "Timing"® Belts

How SHAKEPROOF Protects Your Product's Reputation

Here is the answer to one of industry's toughest problems . . . how to reduce costly inspection rejects and avoid customer complaints due to fastening failure.

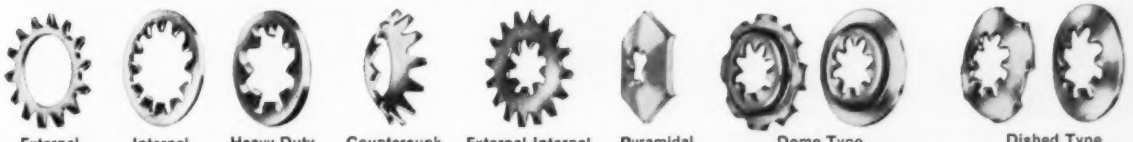
Shakeproof engineers have gathered formidable evidence that only one washer locks . . . where others fail! Their findings, just published in the booklet offered at the right, prove that "weight and thickness" don't lock a fastener, and that "spring action" alone isn't locking action.

They have conducted tests with various types of washers commonly used for protection against failure caused by handling and operational vibration. Results show that only Shakeproof Lock Washers retained 100% relative locking efficiency.

Be sure to protect your product's performance and reputation with the one top-quality, top-performance lock washer . . . Specify SHAKEPROOF . . . the *original* toothed lock washer!

Send for this Free Booklet Today—it is filled with factual test data and actual case histories which show how you can be sure of quality at every step in the assembly of your product.

STANDARD SHAKEPROOF LOCK WASHERS INCLUDE:



External Type · Internal Type · Heavy Duty Internal Type · Countersunk Type · External-Internal Type · Pyramidal Type · Dome Type Toothed or Plain Periphery · Dished Type Toothed or Plain Periphery

SHAKEPROOF *"Fastening Headquarters"®*

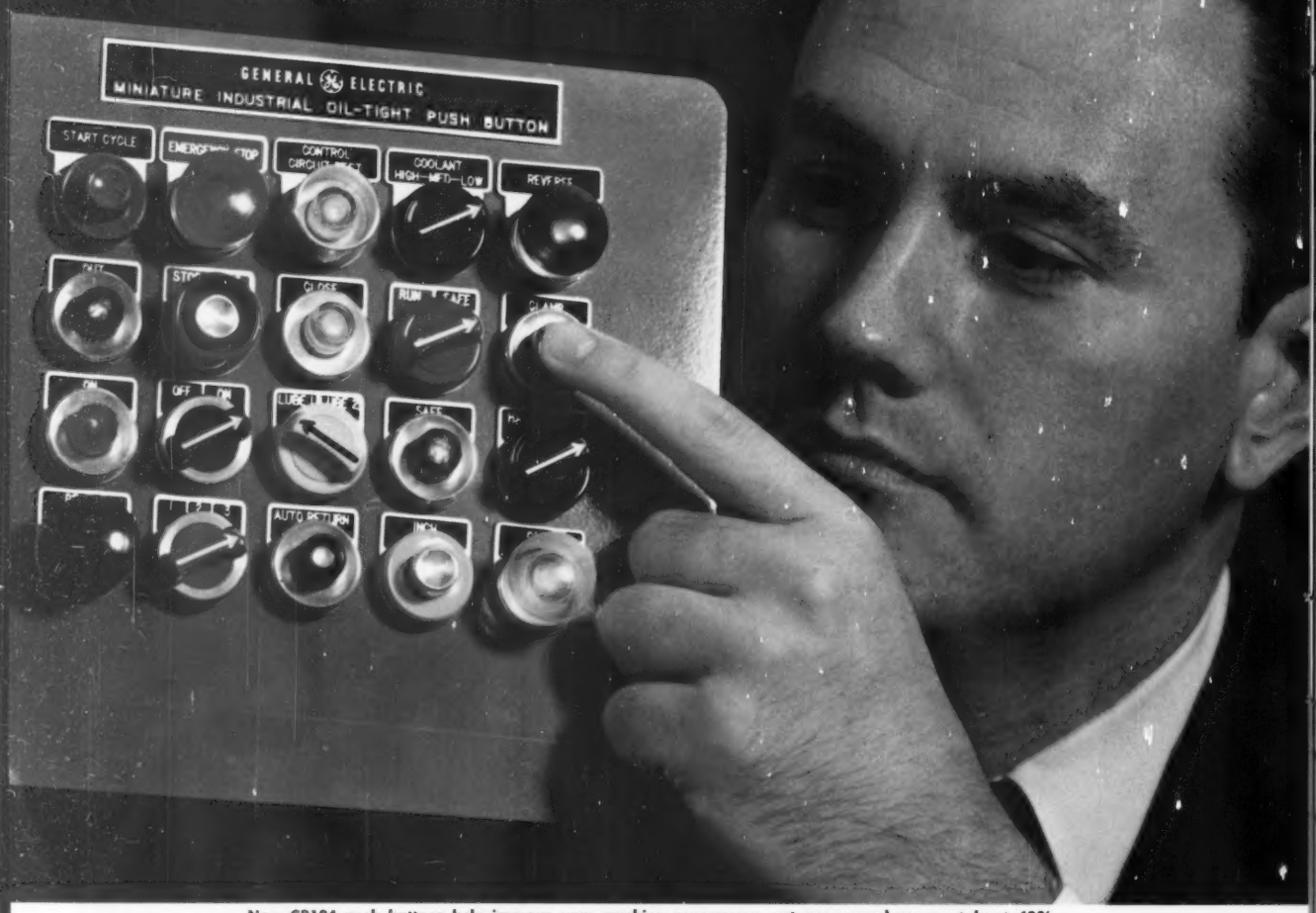
DIVISION OF ILLINOIS TOOL WORKS St. Charles Road, Elgin, Illinois

In Canada: SHAKEPROOF/FASTEX Division of Canada Illinois Tools Limited, 67 Scarsdale Road, Don Mills, Ontario

LOOK TO SHAKEPROOF—THE LEADER IN FASTENING

New

Another Measurable Advantage from General Electric Control



New CR104 push buttons help improve your machine appearance, cut your panel space at least 40%.

FIRST COMPLETE LINE OF INDUSTRIAL MINIATURE OIL-TIGHT PUSH BUTTONS

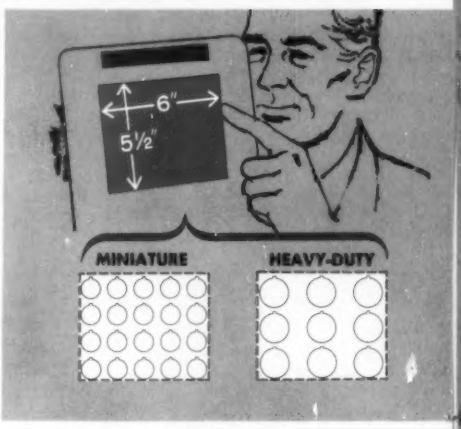
• Push buttons • Selector switches • Illuminated push buttons • Indicating lights • Push-to-test lights

Now you can design entire panels with miniature pushbutton units and cut your panel space requirements at least 40 per cent! General Electric announces the development and immediate availability of industry's first complete Industrial Miniature Oil-tight Pushbutton line.

This new CR104 line offers you the operating and functional units presently available in heavy-duty oil-tight forms —with an attractive appearance that enhances the design of your machines. A wide variety of operators is available, plus various modifications, special units, and nameplates to meet every operating requirement. Color coding is available in *both* operators and rings to provide you the flexibility of many different color combinations. Also, enclosures and pendent stations are available to accommodate from four to 42 units.

FOR MORE INFORMATION on this outstanding new development in control—and the "measurable advantages" it offers you—contact your nearby G-E Apparatus Sales Office, or write for Bulletin GEA-7127, General Electric Co., Schenectady 5, N. Y. 811-10

You get
MEASURABLE ADVANTAGES
WITH GENERAL ELECTRIC CONTROL



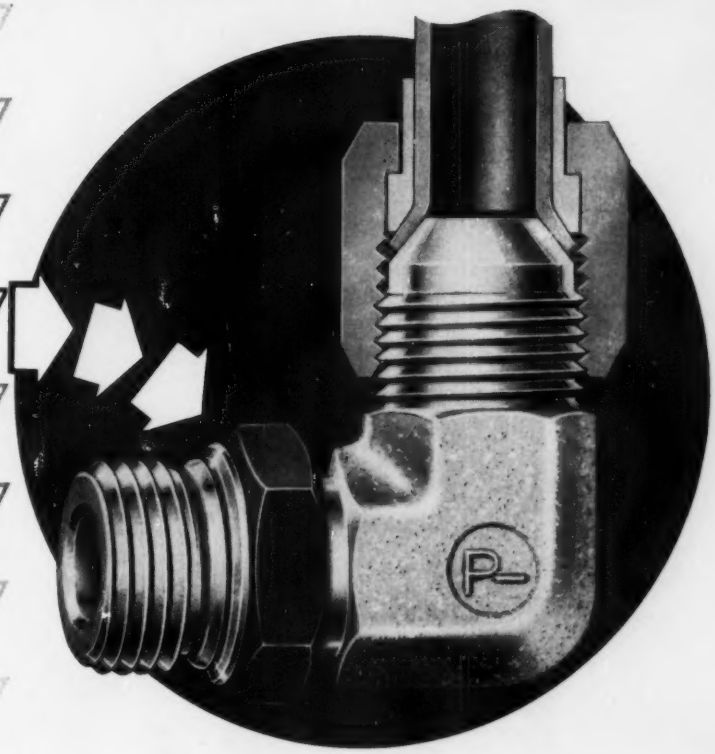
SAVE PANEL SPACE. Twenty new General Electric miniature units fit into the *exact* space required for nine heavy-duty oil-tight push buttons.

GENERAL ELECTRIC

PARKER PIONEERS AGAIN

LEAKPROOF PORTS WHATEVER THE FLUID!

NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW
NEW



PARKER NOW OFFERS A METAL SEAL TO FIT THE S. A. E. STRAIGHT THREAD BOSS

Parker, whose straight thread fittings and straight thread ports have been accepted by S.A.E. (and now by J.I.C.) as industry standards for hydraulic devices, has now developed a **stainless steel** seal for use where the convential, synthetic rubber "O" ring is not acceptable.

Their new all-metal straight thread fitting features this resilient stainless seal, **which seats within the confines of the S.A.E. straight thread boss configuration.** The new seal cannot be removed from the fitting and, therefore, cannot be lost. It can be used again and again without damage to the boss or to itself. Because it is 304 stainless, it works equally well with every known hydraulic fluid, petroleum-base or fire-resistant.

Parker offers steel and stainless steel straight-thread fittings with stainless seals in both their "Triple-lok®" 37° flare design (illustrated) and their "Ferulok®" flareless, "bite-type" design. Also available from Parker are tools with which to cut the mating S.A.E. boss.

Hydraulic designers who have hesitated to standardize on the leakproof S.A.E. straight thread boss on applications where they could not be sure what hydraulic fluid would be used are invited to write for complete engineering test data on this new development.

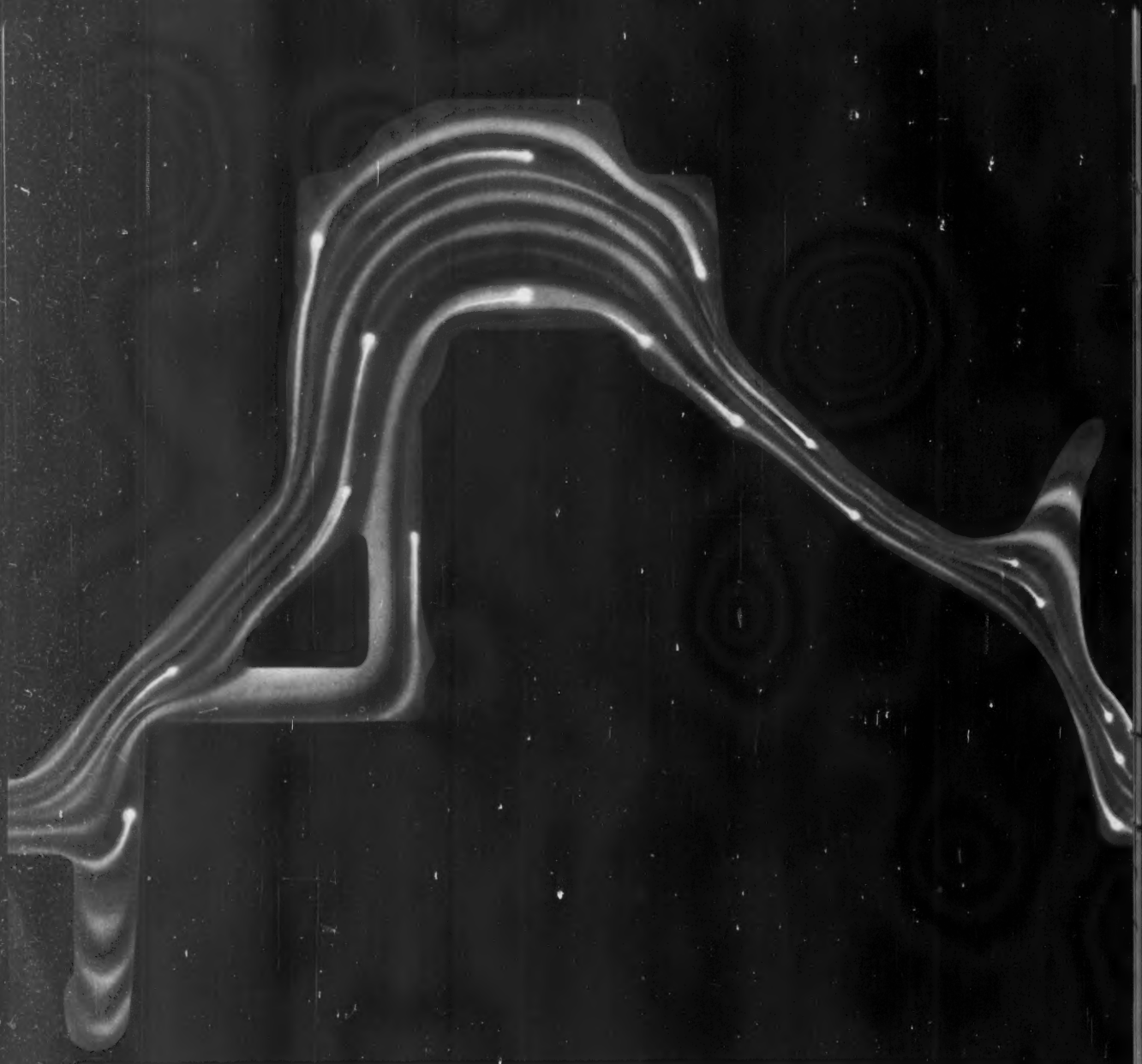
PARKER HANNIFIN CORPORATION

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3139-PH

←Circle 483 on Page 19

Circle 484 on Page 19



Liquid flow through a cross section of a Malleable differential carrier.

For Performance-Tested Dependability...Use Malleable

Molten metal flows evenly into all parts of the mold, then solidifies into pre-shaped parts with uniformly dependable properties throughout. Malleable iron castings will stand up under extremes of tension, impact, torsion, shear, fatigue, wear, heat, cold, and corrosion. They also offer maximum economy, are easy to work, and are versatile enough for parts ranging from a few ounces to hundreds of pounds.

The more manufacturers know about Malleable castings, the more they use Malleable to improve quality and increase profits. Get the full story on Malleable . . . Contact any of the progressive companies that display this symbol —

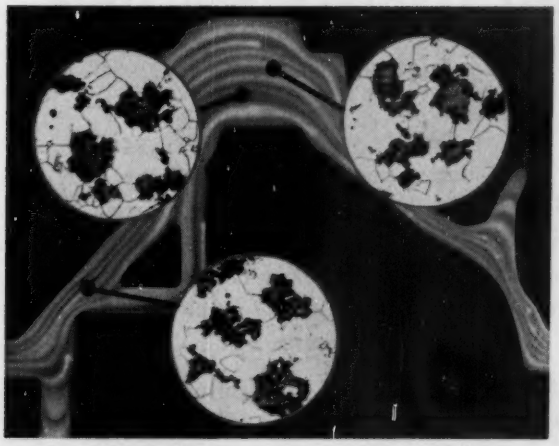
MEMBER

MALLEABLE CASTINGS COUNCIL

For details on Malleable's uniformity and reliability contact any company listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

Malleable Castings...
Uniformly Dependable All The Way Through!

Section a Malleable iron casting . . . check it under the microscope. You will find it shows a similar microstructure all the way through . . . and, therefore, gives you unvarying strength, toughness, and easy machinability.



Structural uniformity in a typical Malleable casting is seen in these micrographs from thick and thin, center and near-surface areas of the automotive differential carrier shown in the color illustration. Samples are magnified 100 times after 3% nital etch.

Uniformity Assures Design Versatility and Easy Machinability

Malleable's structural uniformity and unvarying strength permit designs of any practical configuration based on the functional requirements of the part. The malleablizing process relieves internal stresses, and assures fast, problem-free machining.

The Proof Is In The Using

The ultimate proof of a material's quality comes from actual use by customers. Truck and car torsion arms absorbing millions of road shocks, vital tractor parts performing equally well in the Sahara and the Antarctic, and thousands of other applications provide continuous proof of Malleable's unexcelled uniformity and reliability.

Free Assistance and Information

Any member of the Malleable Castings Council will be pleased to assist you in making engineering decisions for effective use of Malleable castings. For further information, call or write today to any of the companies listed below for *Data Unit No. 103 "Uniformity"*, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

For Quality and Economy... Use MALLEABLE

For Service In Your Area Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

This New V-Belt Drive

Saved the Heil Co. $40 on every Dehydrator Unit

When Cyclo-Matic Dehydration Units were recently redesigned for greater flexibility in handling different kinds of materials, The Heil Co. engineers decided to incorporate separate motors to drive the main fan and cooling fan, the compressor pump, oil pump, and revolving drum, all of which had previously been driven from one motor.

With the greater number of drives involved, The Heil Co. engineers called in a Gates Representative to see if any savings were possible on drive costs through use of new Gates Super High Capacity V-Belt Drives. Here are the savings that were realized . . .

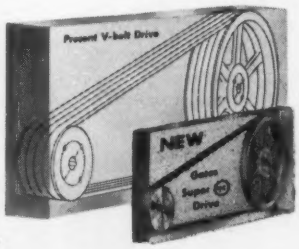
SAVED COST: On the original main drive alone, cost of conventional-type drive was $128.30. On the new main drive, Super HC High Capacity Drives cost only $88.26 — a saving of $40.04 on each main drive! While cost savings on auxiliary drives were not appreciable, additional benefits were reaped here through . . .

SPACE AND WEIGHT SAVINGS: Up to 62% saving in space, and as much as 32% saving in weight, have been realized over and over — not only by The Heil Co., but by hundreds of other manufacturers who have put Gates Super HC High Capacity V-Belt Drives on their products. You can do the same —just by contacting your Gates Representative.

AVAILABLE NATIONWIDE — Gates Super HC High Capacity V-Belt Drives are stocked in key industrial centers throughout the United States and Canada. You'll find your nearby Gates Representative listed in the Yellow Pages of your phone book. Ask him for your free copy of *The Modern Way To Design Multiple V-Belt Drives.*

The Gates Rubber Company, Denver, Colorado

Gates *World's Largest Maker of V-Belts*



Gates Super HC HIGH CAPACITY V-Belt Drives

same hp capacity in smaller package

TPAS40

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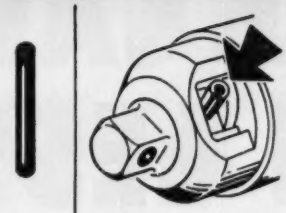
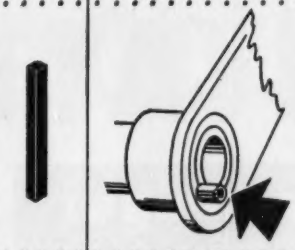
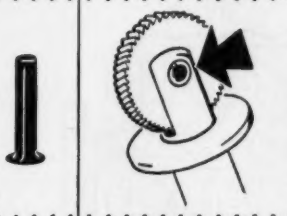
Rollpin® replaces 12 different fasteners



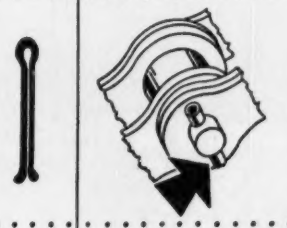
REPLACING A GROOVED PIN . . . in this application, Rollpin serves as a stop pin in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



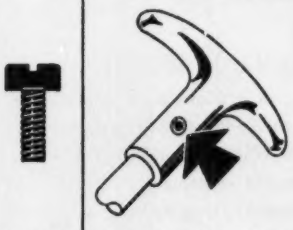
REPLACING A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than previous assemblies.



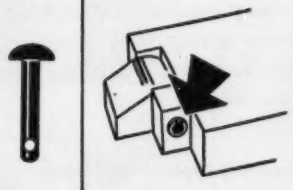
REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.



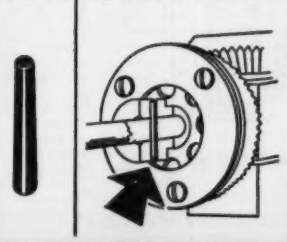
REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.



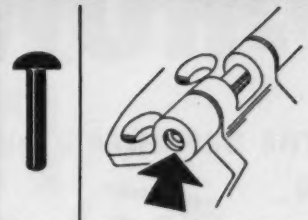
REPLACING A SET SCREW . . . to fasten automobile brake handle a short length Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft for simple handle removal.



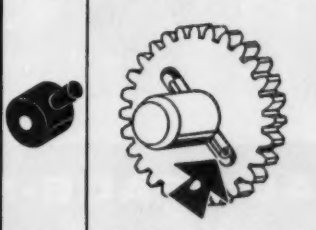
REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application shown is the plate of a home workshop tool.



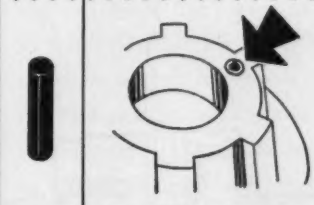
REPLACING TAPER PINS . . . in the assembly of precision differentials eliminated cost of taper pin reamers and the entire reaming operation. Rollpin costs less than a taper pin and installation is cheaper. They remove easily.



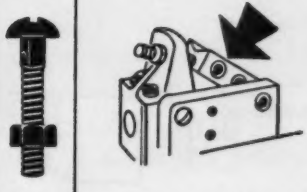
REPLACING A HEADED PIN . . . in this hinge pin application, Rollpin is simply and inexpensively driven in place, greatly reducing assembly costs. Constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.



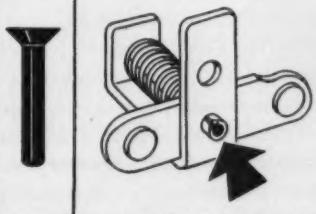
REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. This application, by an office equipment manufacturer, effects major savings in assembly. Rollpin's high shear strength is particularly valuable here.



REPLACING A DOWEL PIN . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.

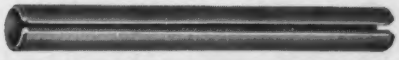


REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots for the linkages in this electric welder. Rollpins may be used with a free fit in outer or inner members depending upon product design requirements.



REPLACING A RIVET . . . Rollpin serves as guide shaft for spring-loaded electrical interlock contacts. This electrical equipment manufacturer reports that rivet failure previously occurred at the clinched end under normal operating impact and vibration.

WHERE CAN YOU USE THIS SIMPLE FASTENER?



Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole. Made in carbon steel, stainless steel and beryllium copper. Write for samples and information, ELASTIC STOP NUT CORPORATION OF AMERICA, 2330 Vauxhall Road, Dept. R47-114, Union, New Jersey.

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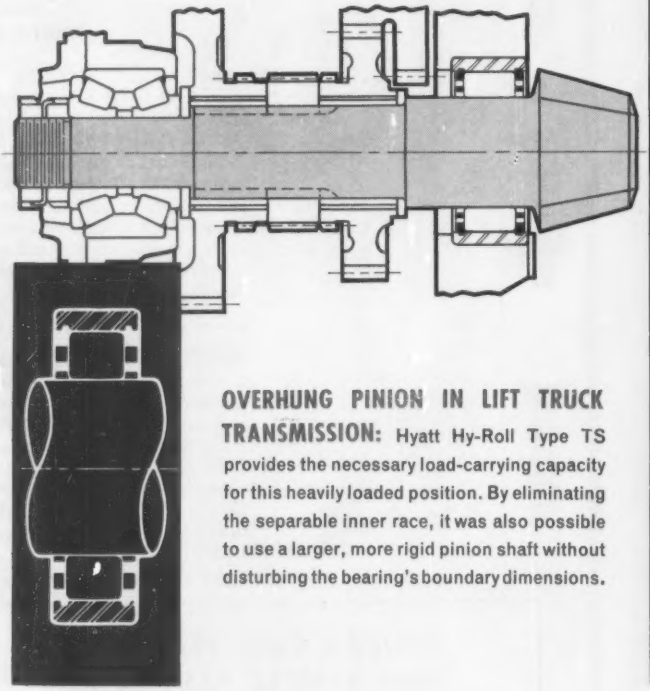
ROLLPIN TRADEMARK

ELASTIC STOP NUT CORPORATION OF AMERICA
2330 VAUXHALL ROAD, UNION, NEW JERSEY

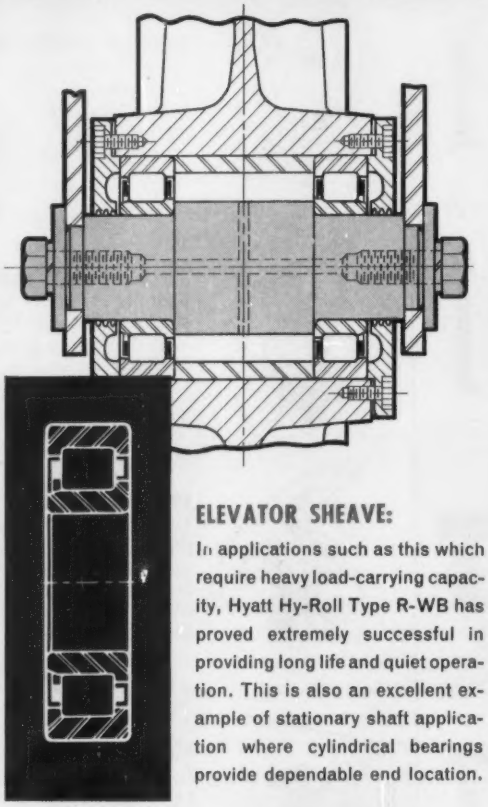
HOW YOU CAN IN LESS HYATT

YOU'LL SOLVE THE DESIGNER'S DILEMMA WHEN YOUR "SPECS" READ HYATT

TYPICAL SPACE-SAVING EXAMPLES!



OVERHUNG PINION IN LIFT TRUCK TRANSMISSION: Hyatt Hy-Roll Type TS provides the necessary load-carrying capacity for this heavily loaded position. By eliminating the separable inner race, it was also possible to use a larger, more rigid pinion shaft without disturbing the bearing's boundary dimensions.

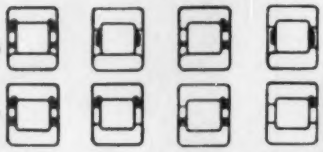


ELEVATOR SHEAVE: In applications such as this which require heavy load-carrying capacity, Hyatt Hy-Roll Type R-WB has proved extremely successful in providing long life and quiet operation. This is also an excellent example of stationary shaft application where cylindrical bearings provide dependable end location.

The separable race can be omitted and rollers operated directly on the shaft or in the housing bore, in instances where the bearing surfaces can be brought to suitable hardness and finish.

For full details on selection and application of these bearings see Hyatt Catalog 150 or call your nearest Hyatt sales engineer.

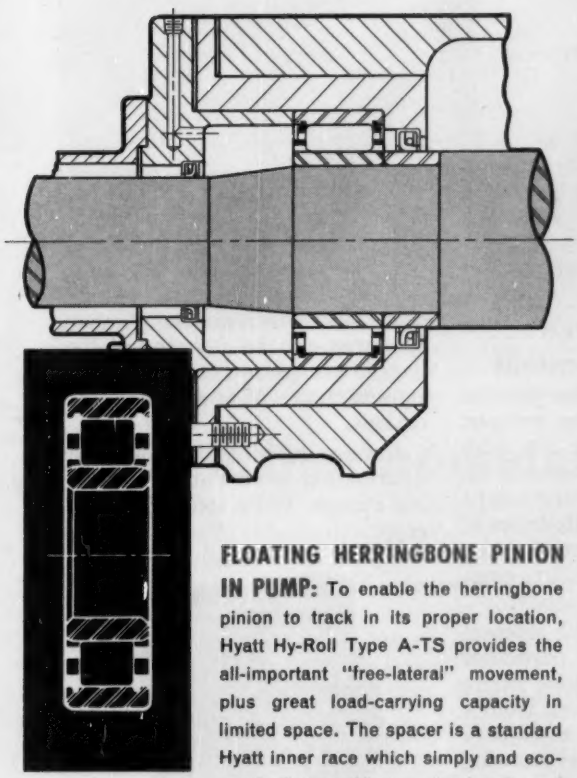
Hyatt produces 10 major bearing types—four have separable inner races



—four non-separable

—and two have separable outer races.

CARRY MORE LOAD SPACE WITH ROLLER BEARINGS



FLOATING HERRINGBONE PINION IN PUMP: To enable the herringbone pinion to track in its proper location, Hyatt Hy-Roll Type A-TS provides the all-important "free-lateral" movement, plus great load-carrying capacity in limited space. The spacer is a standard Hyatt inner race which simply and economically provides a hardened and ground surface for the seal.

One of the dilemmas facing design engineers these days is the result of two contrary trends in modern machine design. The one trend is towards higher horsepowers which require heavier shafts and impose greater radial loads on bearings. The other trend calls for reduction in envelope and housing dimensions to save space and weight wherever possible. The answer is in bearings which will carry more load in less space, and that means cylindrical roller bearings.

The geometry of a cylindrical roller bearing results in inherently greater radial load carrying capacity than other types. There is a larger area of contact between races and rollers and radial capacity is not sacrificed to provide for thrust. Also, straight cylindrical bearings provide better bearing characteristics because they provide true rolling motion.

If you're faced with the problem of designing more load in less space, call on your Hyatt sales engineer. He can draw on Hyatt's extensive experience in the design and manufacture of reliable cylindrical bearings to help you.

HYATT *HY-ROLL BEARINGS* **FOR MODERN INDUSTRY**

IN ROLLER BEARINGS HYATT IS THE WORD FOR GM RELIABILITY

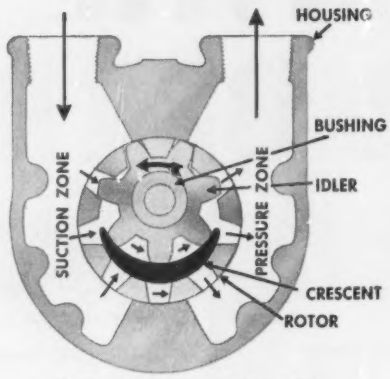
HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

Circle 488 on Page 19

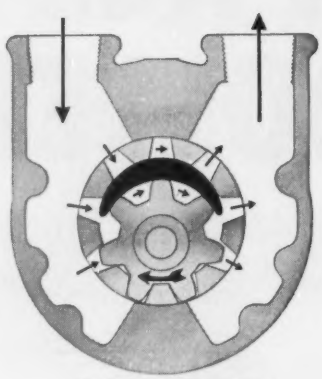
The TUTHILL Internal Gear Pump... and its advantages in reversing applications

by E. H. Schanzlin,
Chief Engr., Tuthill Pump Co.

Extremely high reliability, proven in thousands of applications over a 30 year period, has made Tuthill's internal gear pump an industry standard. The Internal gear construction particularly adapts itself to reversing pump applications as indicated in the sketches at right.



COUNTERCLOCKWISE ROTATION


CLOCKWISE ROTATION

How It Operates

Key elements are the rotor, idler gear and the crescent shaped partition. This crescent shaped partition, shown in heavy black, is cast integral with a moving part called the idler carrier.

In the drawing at left, power is applied in counterclockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

When shaft rotation is changed from counterclockwise to clockwise, as in the drawing at right above, the idler carrier, (including the idler gear and crescent) automatically rotates 180° through the suction zone. This changes the directional flow within the pump without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180° —always through the suction zone. If rotation were again reversed to counterclockwise, the crescent would swing back to its original position (shown at left above).

No valves required . . . ports remain constant

This unique construction permits positive reversing action, without any valves, and with the port positions remaining constant. In addition Tuthill's reversing pumps provide all the other attributes of internal gear construction . . . extremely high reliability, compactness, and high efficiency.

Reversing Pumps with internal gear construction pay particular dividends on applications where the pump must be driven from a reversing shaft or when machinery must be shipped without knowing the ultimate direction of the driving unit.

375 reversing pump models

Tuthill offers a complete selection of over 800 different pumps including 375 different reversing pump models for capacities from 1/3 to 200 GPM; for pressures to 400 PSI; and speeds to 1800 RPM. These include a complete selection of stripped models for incorporation into products. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill's engineers to meet the requirements of specific applications.

Catalog 105 contains complete information on all Tuthill Reversing Pumps. Write today for your copy.

Typical Tuthill Reversing Pump. Model 2RC has capacity of 5 GPM operating at 100 PSI, 1200 RPM.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois

Needle's eye reveals relative size of the thermistor, a tiny bead of Nickel oxide and other materials, used to measure temperatures in and beyond the earth's thin envelope of atmosphere. Made by Gulton Industries, Inc., the thermistor now serves in more than a dozen different missiles and satellites.

"Space thermometer" goes thru needle's eye

Meet the bead thermistor, member of a family of electronic devices now going into everything from midget radios to giant computers and missiles.

This particular thermistor measures temperatures in space — temperatures ranging from 572° F all the way down to 76° below zero Fahrenheit.

You can hardly see the bead with your naked eye. Although it's only *a hundredth of an inch* in diameter, and the lead wires are a mere thousandth of an inch thick, the thermistor is an extremely stable and rugged device, accurate to within a fraction of a degree Fahrenheit.

Made of Nickel oxide and other materials, the thermistor is a space-traveler in many of today's missiles and satellites. It reliably reports on gradients of temperature within the earth's thin atmospheric shield and in outer space. At the same time, it helps record the temperature changes in the missile's skin and its interior.

What is a thermistor? Its name, which comes from THERMal resISTOR, begins to explain. Temperature changes as small as 1/50th of a degree produce a measurable change in the electrical resistance of the pellet. The resulting increase or decrease in circuit current can then be used directly, as a signal, or can be recorded in the form of temperature readings.

Originally developed by Bell Telephone Laboratories for communications equipment, thermistors are now widely used where a tiny, precise, and dependable thermometer is needed: in medical research, in over-load switches to protect electric motors, and in shipment of perishable foodstuffs, for example.

The role of Nickel in the thermistor is only one example of the remarkable versatility of this element.

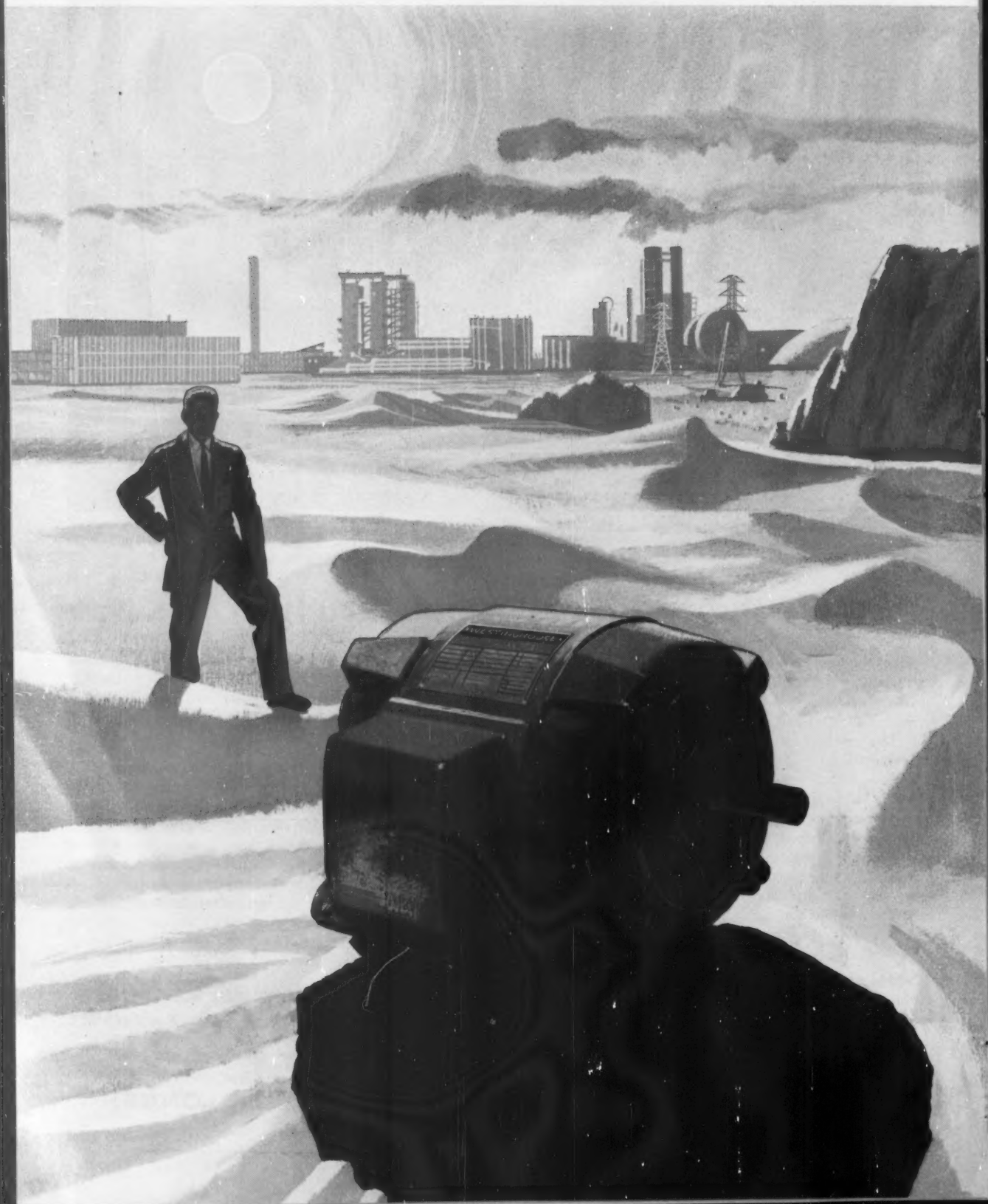
Be sure to investigate Nickel and Nickel compounds whenever you are faced with a problem calling for unusual electrical or electronic properties...in fact, for *any* unusual metal problem. And don't hesitate to call on us for technical data to help you solve your material-selection problems.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N.Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

NEW WESTINGHOUSE *Guardistor*



MOTORS LET YOU USE ALL THE HORSEPOWER YOU PAY FOR...SAFELY

The man and the motors from Westinghouse now provide absolute protection against motor failure caused by excessive heat . . .

Our Engineering Manager says:
"With the breakthrough development of the Westinghouse Positive Temperature Coefficient thermistors, for the first time we can provide inherent protection against motor failure caused by excessive heat. The solid-state thermistors buried in the windings instantly sense excessive heat from any cause and simultaneously warn of trouble or automatically take the motor off the line. Thus, motor protection is placed where only true motor protection can be . . . in the windings."

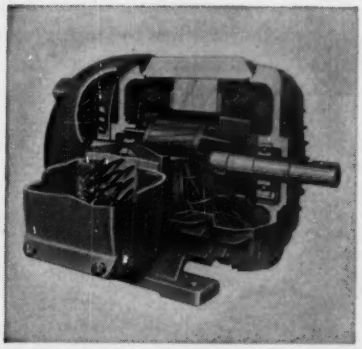
Our Marketing Manager says:

- "You can match the motor to the load . . . use all the motor you are paying for.
- Provides positive protection based on winding temperature . . . *not* load current and/or power supply fluctuations.
- Eliminates time and expense of changing winter-summer heaters. No nuisance tripping, it's fail-safe . . ."

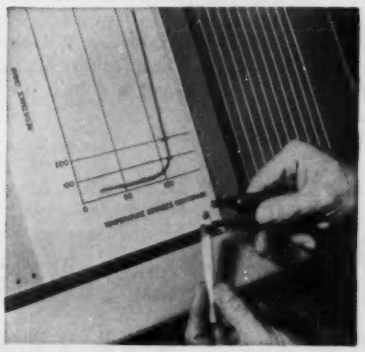
Call your Mr. Westinghouse for the application of a Guardistor* motor to your drive requirements . . . write for *Questions and Answers About . . . Guardistor* (B-7876). Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. You can be sure . . . if it's Westinghouse.

*Trade-Mark

J-22160-R



Unlike remotely located sensing devices, PTC thermistors are buried in the windings of the Guardistor motor, instantly equating all temperature factors.



Ever alert PTC thermistors constantly totalize temperature, statically triggering an action *only* if critical temperature is reached.

MOTOR & GEARING DEPARTMENT

Westinghouse

Circle 491 on Page 19

SEAMLESS STEEL BARRELS and other pump components of Harbison-Fischer's rod and tubing displacement pumps show great size range required to bring oil to the surface. Pumps vary on I. D. from ¾ inch to 5¾ inches; from 3 to 42 feet in length. Harbison-Fischer counts on commercial quality Pittsburgh Seamless Mechanical Tubing to get a 4 to 6 micro-inch I. D. finish with minimum clean-up expense.

Pittsburgh Seamless Tubes Give a Lift...

WHEN OIL MEN MAN THE PUMPS

When the gusher quits gushing and the oil flow slows to a trickle, it's time for oil men to man the pumps.

Pittsburgh Steel Company helps give them the lift they need with seamless mechanical tubing for sub-surface displacement pumps made by Harbison-Fischer Manufacturing Company of Fort Worth, Texas.

Nine of every ten producing wells must be pumped—and most depend on slender, precision-made rod and tubing pumps for efficient oil production. Harbison-Fischer has supplied them to the oil industry for more than 25 years—"The Best Pumps in the Oil Patch."

Among its eight types and wide range of sizes, there's a Harbison-Fischer pump to match every lifting job and well condition, whether it be depth, heat, pressure, corrosion or abrasion.

Pittsburgh Seamless Mechanical Tubing forms the pump barrel that contains plungers and valves. Besides destructive conditions below surface, barrels often must bear the weight (5 to 6,000 psi) of a fluid column of oil 10,000 feet or more deep.

● **Tight Specs**—To meet rigid API standards as well as its own manufacturing needs, Harbison-Fischer requires mechanical tubing with exact chemical and physical properties, and close tolerance I. D. and wall dimensions.

It demands tubing that is exceptionally straight, free of seams, laps and pits; made of steel that is machinable, and—in the high carbon range—fine grained and hardenable.

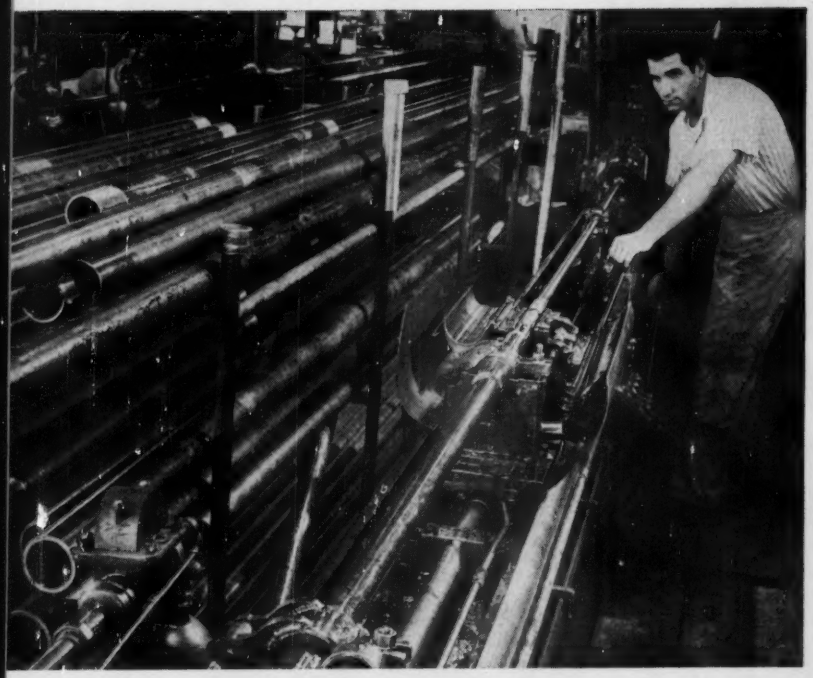
Pittsburgh Steel answers these requirements with mechanical tubing in C-1015 and C-1040 grades in commercial quality to help Harbison-Fischer hold processing to a minimum.

● **Fine I. D. Surface**—In production, Harbison-Fischer wants minimum stock removal to obtain a mirror I. D. finish and extreme straightness.

On its dozen long-stroke hydraulic hones, H-F holds the I. D. stock removal to a few thousandths of an inch. Says Harbison-Fischer:

"The honed I. D. must be entirely free of pits. We want a four to six micro-finish. So you can see why the tubing's I. D. mill finish is important."

After threading and honing, every barrel is re-straightened to a tolerance of .015 TIR (total indicator



STRAIGHTNESS, CLOSE TOLERANCE wall thickness and absence of seams, laps and pits in Pittsburgh Seamless Tubing mean fast, easy clean-up on horizontal hones. Minimum stock removal in honing tube's inner surface results in a mirror finish. Six-foot tube being set up here will become working barrel of two-inch tubing pump.

HONED TUBE GETS RIGID INSPECTION. Inspector uses I. D. micrometer to make certain barrel of 3-inch tubing pump stays within tolerance limits of —.0000/ +.0015 inch.

PRODUCTION PERSONNEL check wide variety of tubing used by Harbison-Fischer to produce "Best Pumps in the Oil Patch" for world-wide market.

reading) to overcome distortion caused by working of the tubing.

For installations where hard pumping and hard wear are factors, Harbison-Fischer heat-treats high carbon barrel tubing by an exclusive electronic process. The process penetrates the I. D. a predetermined depth to produce exceptional wearing quality, while permitting the O. D. to remain ductile and shock resistant.

Applications such as Harbison-Fischer's are typical of the uses to which Pittsburgh Seamless Tubing is put. There are thousands of them.

If you manufacture cylindrical products or parts requiring close tolerance, smooth surface or specific physical properties, Pittsburgh Seamless Mechanical Tubing can saye you time and processing costs. Contact one of the district offices or distributors listed at the right. A Pittsburgh Steel representative will show you how.

Pittsburgh Seamless Distributors

Baker Steel & Tube Company
Los Angeles, California

Chicago Tube & Iron Company
Chicago, Illinois

Cleveland Tool & Supply Co.
Cleveland, Ohio

Drummond, McCall & Co., Ltd.
Montreal, Quebec, Canada

Edgcomb Steel Company
Philadelphia, Pennsylvania

Gilmore Steel Corporation
San Francisco, California

Earle M. Jorgensen Co.

Kilsby-Tubesupply, Division of
Republic Supply Co.
of California
Los Angeles, California

Mapes & Sprowl Steel Co.
Union, New Jersey

Metal Goods Corporation
St. Louis, Missouri

Miller Steel Company, Inc.
Hillside, New Jersey

A. B. Murray Co., Inc.
Elizabeth, New Jersey

C. A. Russell, Inc.
Houston, Texas

Ryerson, Joseph T. & Son, Inc.

Solar Steel Corporation
Cleveland, Ohio

Standard Tube Sales Corp.
Brooklyn, New York

Steel Sales Corporation
Chicago, Illinois

Tubular Sales
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Circle 492 on Page 19

STONE AGE or JET AGE

how does your chrome plating stack up?

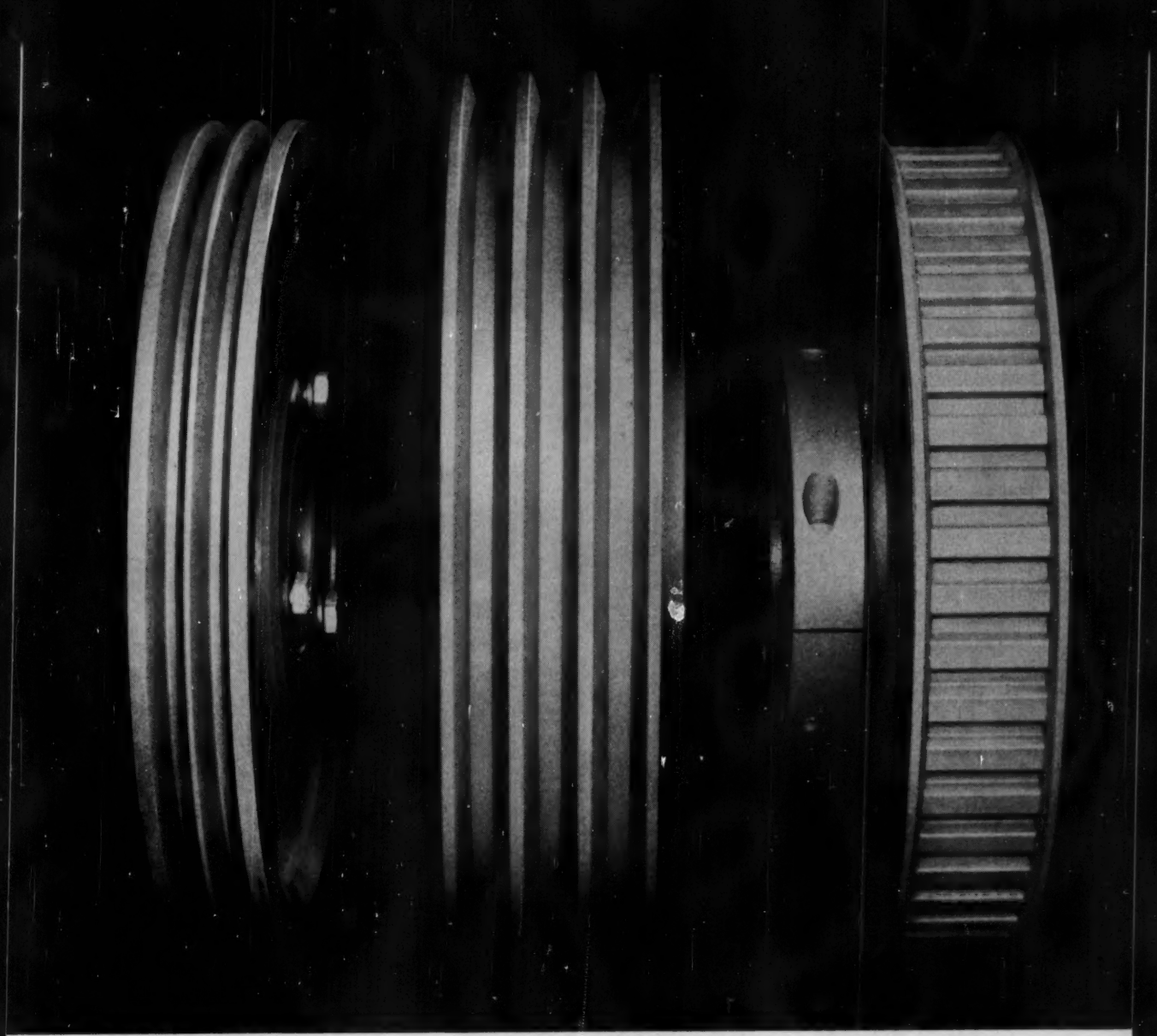
You can keep your chrome-plating process in step with today — with Diamond CPA 1800®.

For example: The CPA 1800 process is now being used in advanced jet engine experimentation — meeting the severest tests for corrosion and abrasion-resistance tolerances ever imposed on high-pressure seals.

This same jet-proven additive is available to you and to your chrome-plate source. To increase plating speed and covering power. To allow a broader operating range. To simplify anoding and produce a brighter, harder coating. To improve the metallurgical characteristics of chromium plate.

In short: Diamond CPA 1800 can cut your unit costs and save you money. Diamond developed it. Your Diamond CPA 1800 Distributor can supply it where and when you need it. For further information write or call Diamond Alkali Company, 300 Union Commerce Building, Cleveland 14, Ohio.

Diamond Chemicals



THE NEW MULTI-WEDGE DRIVE SHEAVE MULTI-V DRIVE SHEAVE POSITIVE DRIVE PULLEY

FIRST, LOOK AT THREE

Measured by horsepower handled, the three wheels shown are the same. But Multi-V (long the industry favorite) is bulky, as compared with the new lighter, equally strong Multi-Wedge Drive. And the Positive Drive combines advantages of the chain and gear with the advantages of the belt.

For all three, even in fractional sizes, Worthington supplies the tapered, split QD hub with the Golden Screws. Or, of course, it supplies bored-to-suit hubs for special applications. And for every drive, from 1/20 hp to 600 hp or more, the proven Worthington-Goodyear belts are supplied. In fact, the QD hub plus these belts in any of the above three drive types make them most compact, flexible and long-lived.

Which drive you choose is up to you. But don't toss a coin. To help you decide, Worthington has just issued new engineering manuals on all three drives, including "how-to-figure-it" information. For low horse power drives, get the "Fractional HP" manual. Ask the Worthington distributor listed in the Yellow Pages for the manual(s) you want. Or send the coupon listed below.

WORTHINGTON CORPORATION
Section 79-33, Oil City, Pa.

Please send me the engineering manuals checked here.

☐ Multi-Wedge ☐ Multi-V ☐ Positive Drive ☐ Fractional HP

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WORTHINGTON

Circle 494 on Page 19

PACKLESS

4-way, balanced, lapped spool and body assembly eliminates seals to provide

50 MILLION CYCLES

of total reliability in Alkon's new Series A ¼" air valves for vacuum to 200 psi air service. Carbide-hard working and sealing surfaces at these

LOWEST PRICES

single solenoid valve	$34.50	double bleeder valve	$25.00
double solenoid valve	49.00	hand valve	21.00
single pilot valve	21.00	foot valve	23.00
double pilot valve	22.00	palm button valve	20.50

All actuators — hand, foot, solenoid, pilot and bleeder — in single or double combinations available for maximum circuit flexibility, easy installation, less maintenance.

SUB-BASE MOUNTING FREE

ALKON also manufactures versatile cylinders and pneumatic drill units.

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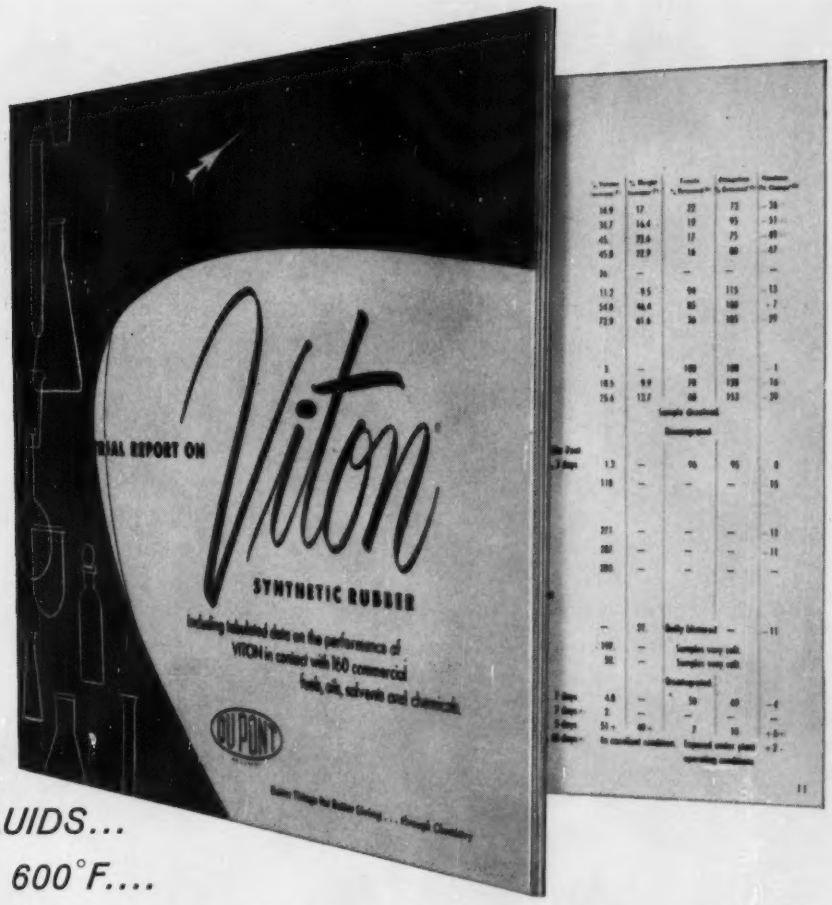

HOW TO COMBAT 160 DIFFERENT FLUIDS... AND HEAT UP TO 600°F....

WITH VITON® SYNTHETIC RUBBER

In a centrifugal heat exchanger, *heat-resistant O-rings made of* VITON *outlast other elastomer seals 25 to 1 . . . are unharmed by operation at temperatures as high as 525° F.!*

In a refinery valve, *seat and O-rings of* VITON *still give positive shutoff after more than a year's service with benzene!*

In a tank farm loading system, VITON *packings have handled a wide range of solvents, both aromatic and aliphatic, for over two years without deforming or losing their resilience!*

THESE are just a few of the many industrial applications where VITON synthetic rubber is cutting operating costs, doing jobs no other rubber could do. "Industrial Report on VITON" brings you more examples, plus latest engineering facts and figures on Du Pont's improved heat and fluid resistant elastomer. Here's a brief summary of its contents:

COMPLETE HEAT AND FLUID RESISTANCE DATA—Seals, gaskets, hose and other products made of VITON perform at temperatures from –40° F. to +600° F. "Industrial Report on VITON" gives more details, and outlines VITON'S resistance to 160 commercial fluids.

PHYSICAL AND RESISTANCE PROPERTIES—Information is provided on hardness, tensile strength, elongation, compression set, electrical and low temperature properties, as well as resistance to ozone, weather and sun.

This reference booklet should be in *your* permanent materials file. Fill in and mail the coupon below for your copy. For information on specific parts made of VITON, and how they can cut your operating costs, see your rubber goods supplier. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MD-11, Wilmington 98, Delaware.

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REG. U. S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

SYNTHETIC RUBBER
NEOPRENE HYPALON® VITON® ADIPRENE®

----SEND FOR YOUR COPY NOW----

Elastomer Chemicals Dept. MD-11
E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware

Please send me a copy of
"INDUSTRIAL REPORT ON VITON SYNTHETIC RUBBER"

Name _____

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Firm _____

Address _____

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Circle 496 on Page 19

Select from full lines to operate and control a single OEM product . . . or a plant's entire production line!

Schrader means quality . . . in complete lines of double-acting and single-acting cylinders in a variety of sizes . . . including JIC and miniature cylinders. Schrader Air Cylinders . . . as well as complete lines of Valves and Accessories . . . are at work on many OEM products and in thousands of plants performing countless jobs. Your Schrader Distributor is fully stocked . . . staffed with experts to help you solve any air circuitry problem.

The complete range of sizes and types of air circuitry products is stocked and cataloged by your Schrader distributor. Consult the yellow pages or write Schrader.

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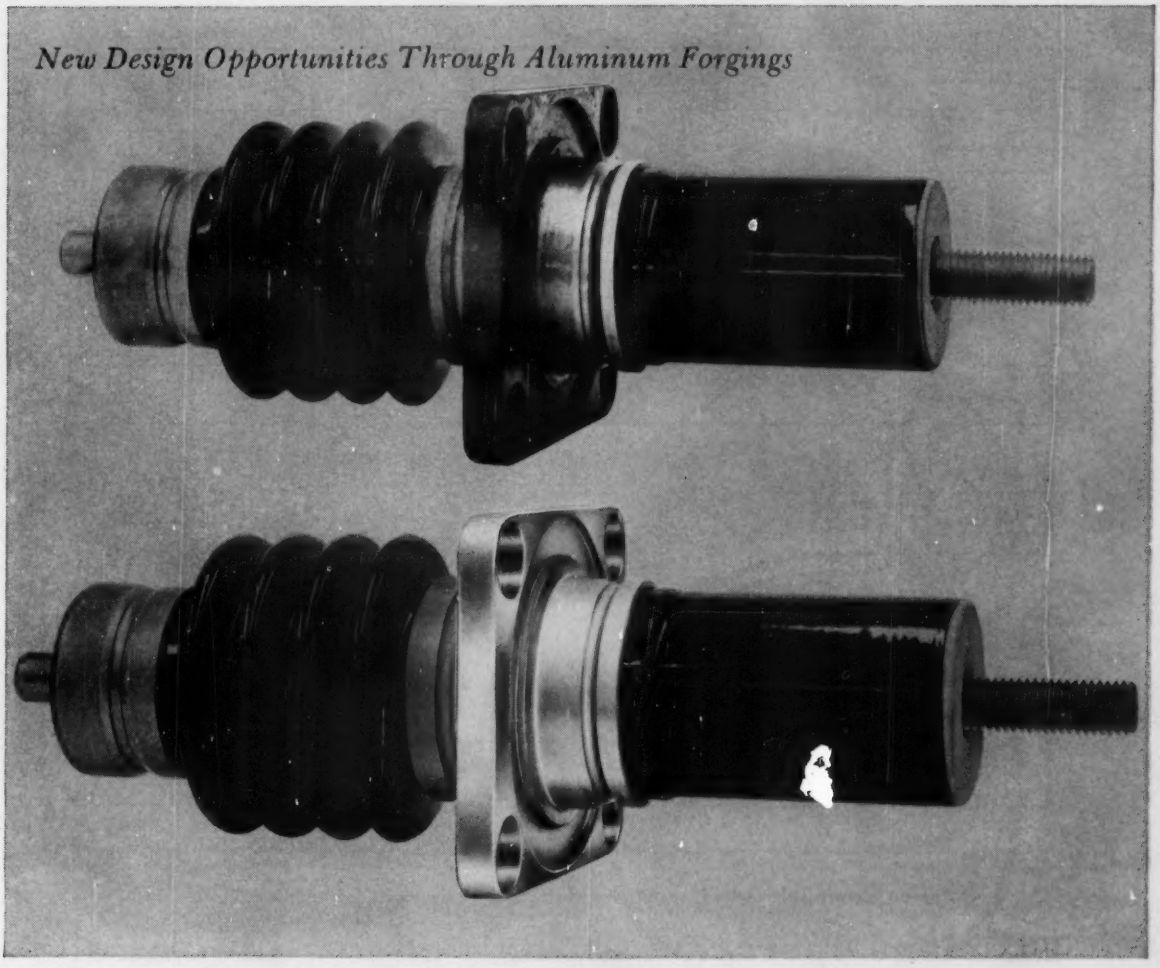
QUALITY AIR CONTROL PRODUCTS

New Design Opportunities Through Aluminum Forgings



which bushing has 5 design advantages?

The one below—because its flange is a strong, light Kaiser Aluminum forging!

The bushing at the top, used previously on large transformers by Westinghouse Electric Corporation, includes a two-piece steel and copper flange assembly with a brazed joint. The bushing below features the forged aluminum flange that replaced it. Here's why:

1. **Increased Reliability.** With no brazed joint, the possibility of leakage at this point was eliminated, and costly testing of the flange is no longer required.

2. **Simple One-Piece Design.** By designing the bushing flange as one piece instead of two, important cost advantages were realized over the steel and copper assembly.

3. **Added Strength.** The forged aluminum bushing flange is stronger. During the forging process, grain flow lines of the metal concentrate at points of greatest stress to produce a part of maximum strength and toughness.

4. **Light Weight.** The aluminum bushing flange weighs only one-third as much as the steel and copper bushing. Westinghouse saves money on shipping costs.

5. **Corrosion Resistant.** The aluminum bushing flange can't rust, resists corrosion. Costly painting is eliminated.

Find out now how aluminum forgings can best serve your design requirements. We'll be glad to assist you—just mail the coupon!

KAISER ALUMINUM

KAISER ALUMINUM & CHEMICAL SALES, INC.
Dept. FO-325 (M) Kaiser Center
300 Lakeside Drive, Oakland 12, California

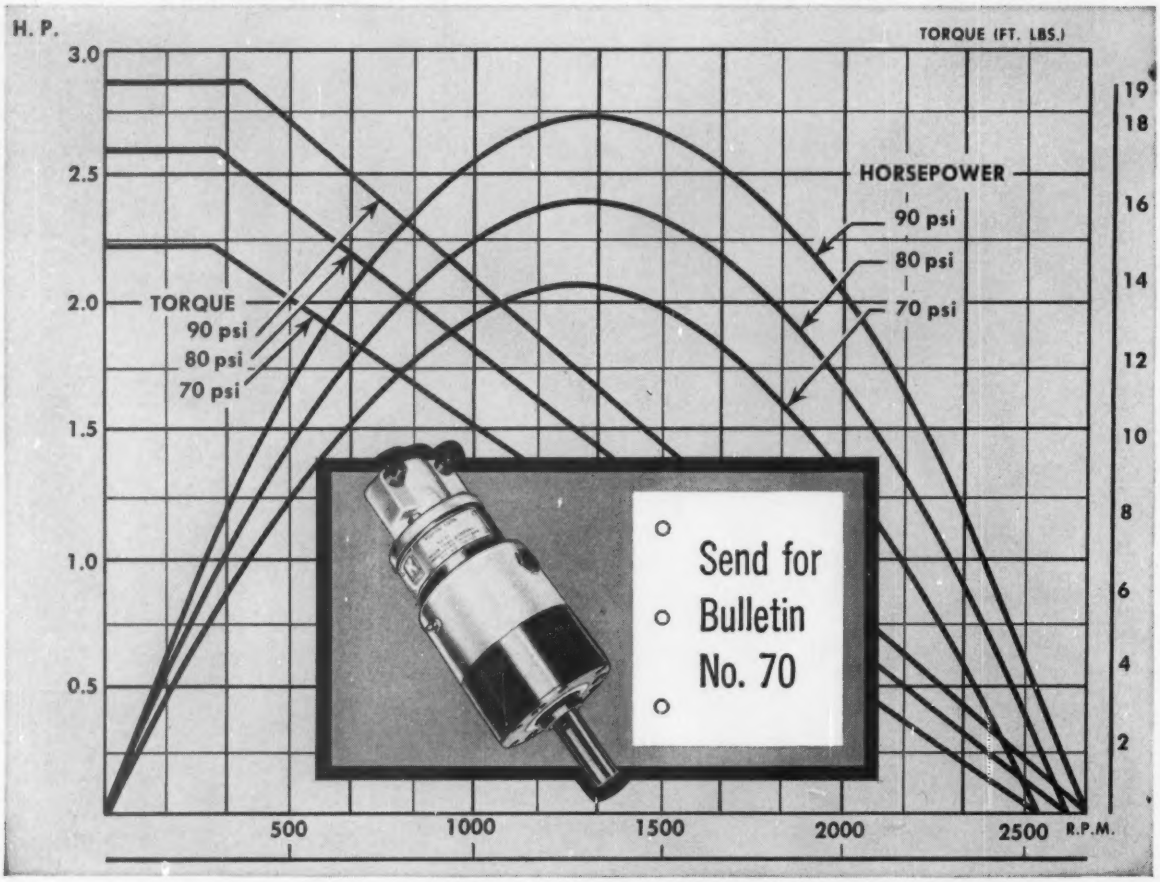
Please send me latest information on commercial aluminum forging availabilities, tolerances and hand forging designs.

NAME_____

COMPANY_____

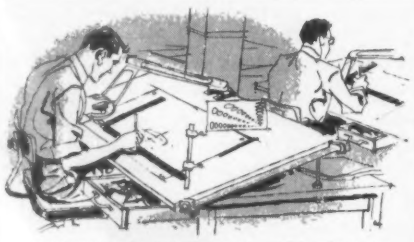
ADDRESS_____

CITY_____ STATE_____



Typical performance curves for one size of Gardner-Denver axial piston air motors.

Efficient operation at high or low pressure . . . Gardner-Denver axial piston air motor



WHEN YOU NEED A "SPECIAL"

. . . talk to the Gardner-Denver man—a specialist himself. He can help you design applications, special mountings, special controls. He'll see that your "special" is quality-engineered by experienced Gardner-Denver men, for there's no substitute for men—our 100-year philosophy of growth.

Here's a rugged, compact axial piston air motor from Gardner-Denver that operates efficiently whether air pressure is high or low. Therefore, it can be applied to low-speed, high-speed or infinitely variable speed drives—simply by regulating air supply. Sizes from 0.6 to 2.7 hp, with free speeds from 450 to 4800 rpm, stall torques to 110 ft.-lb.

Compact design permits use in places where space is limited. Stout spindle, tough bearings and rugged case give this air motor the ability to carry an overhung load as great as 1000 lb. with no external support. Rugged construction and precision parts insure maximum service with minimum maintenance. Can be mounted in any position.

This Gardner-Denver air motor also features instant starts and stops, reversible operation and no spark hazard. It works in heat, moisture or dust . . . can't burn out. Can air power help *your* design? For complete information, contact your nearby Gardner-Denver representative or write for Bulletin 70-1.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

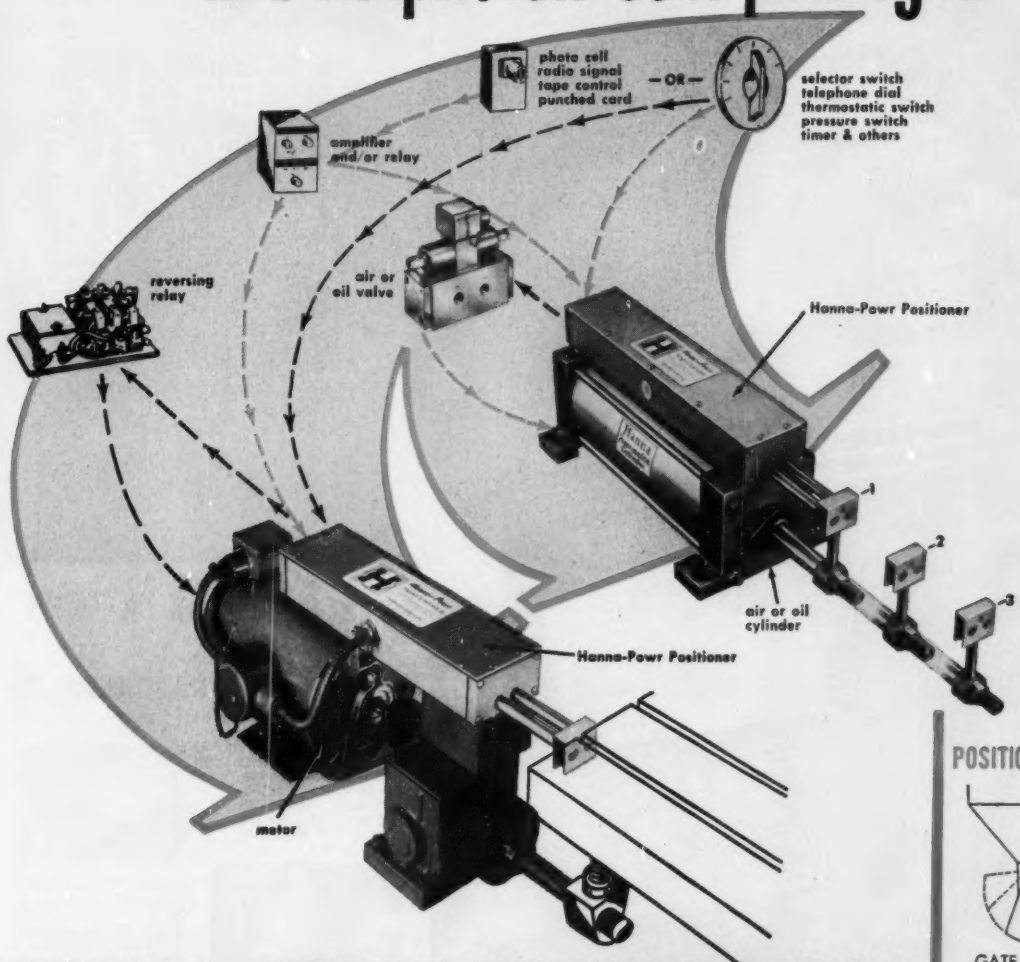
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

Circle 499 on Page 19

BRAND NEW IDEA... multiple positioning in a simple, low cost package!



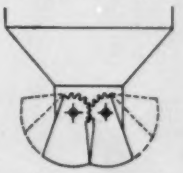
HANNA-POWR® POSITIONERS

THE NEW HANNA-POWR POSITIONER is a simplified, low-cost servo-mechanism used with air or hydraulic cylinders, electro-mechanical or other power drives to responsively achieve predetermined positions. The POSITIONER will also feed a signal to a read-out station to indicate the position point. Controls, such as selector switches, timers, thermostatic switches and others, feed signals to the POSITIONER for station selection—as many as 14 per foot of stroke. Infinite variations in positions are possible by simple movement of the adjustable limit switches. Stroke lengths may vary from a few inches to several feet to suit each application.

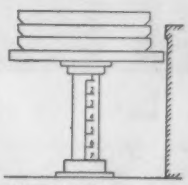
HANNA-POWR POSITIONERS save the time of designing special controls and cams, offer convenience of installation with one simple mounting for a group of controls, and cut maintenance costs by protecting all controls in a sturdy, dust-tight housing.

Your individual problems will suggest many uses for the HANNA-POWR POSITIONER. For more detailed information call your nearby Hanna Representative, (See "Cylinders" in the yellow pages), or write us for Catalog 500.

POSITIONED POWER



GATE POSITIONING



MULTIPLE POSITIONING OF LOADS

INDEXING

60 Years' Experience In Building The Finest Cylinders, Valves and Other Hydraulic and Pneumatic Equipment

Hanna Engineering Works

1751 Elston Avenue • Chicago 22, Illinois • BRunswick 8-2710

NOW

LOW COST, AUTOMATIC REPRODUCTION OF ENGINEERING DRAWINGS...FROM MICROFILM

XEROX COPYFLO 1824 PRINTER

MAKES THE SAVINGS OF A UNITIZED MICROFILM SYSTEM POSSIBLE IN SMALL OR DECENTRALIZED ENGINEERING DEPARTMENTS

SIMPLE AS A·B·C

A. Operator inserts microfilm aperture card.

B. Next, operator inserts a sheet of ordinary paper or vellum, or an offset paper master. Insertion starts automatic printing and processing cycle.

C. The first print is automatically delivered in 30 seconds, subsequent prints (of the same or different drawings) every 15 seconds.

Now, you can get a ready-to-use engineering print . . . in seconds and *on ordinary cut-sheet paper* . . . from a microfilm aperture card.

The XeroX® Copyflo® 1824 printer makes 18″ x 24″ prints, or smaller, at an extremely low cost. Also reproduces on vellum or offset paper masters.

Operation is automatic. Prints emerge dry, ready for immediate use, as fast as four a minute.

And the quality of reproduction is excellent. The image is sharp black-on-white and won't rub off. There is no odor, no waste, and the paper may be written on with pencil or pen.

Thus, regardless of your engineering-drawing-reproduction volume, you can now enjoy the tremendous savings in time, money, space, and materials of a unitized microfilm system.

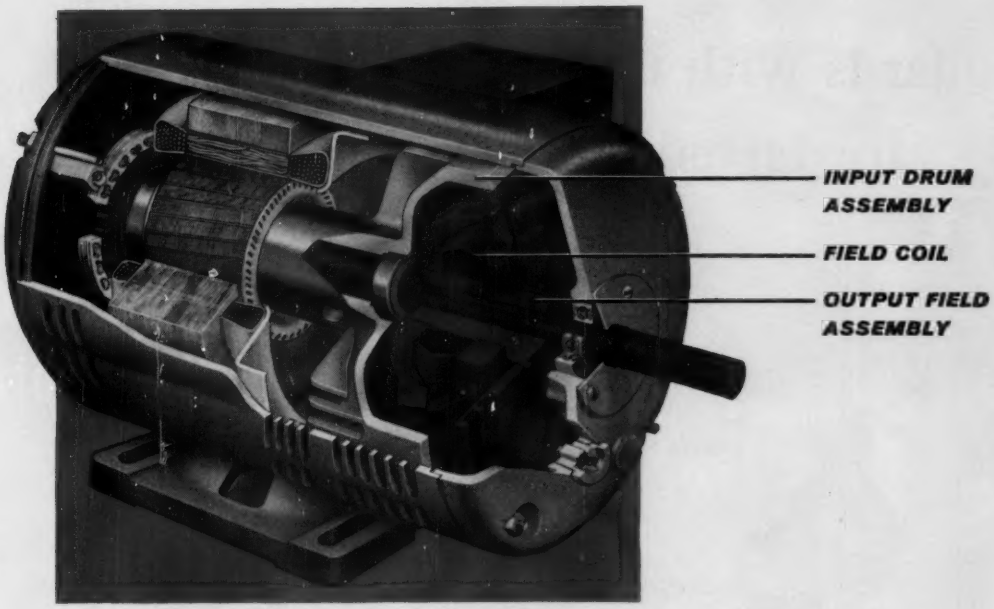
Formerly, such economies . . . from $20,000 to $100,000 annually . . . required a substantial reproduction need to make the system feasible.

Today, however, the Copyflo 1824 printer brings the same proportionate benefits to small-volume users as to large. No need now for vast files of engineering drawings. Microfilm aperture cards take only a fraction of the storage space required for other reproducibles. No more costly waiting for prints. And prints made by a Copyflo 1824 printer are so inexpensive, your engineers can discard them after use.

Write today for 1824 booklet giving full benefits you can expect from a Copyflo 1824 printer. Haloid Xerox Inc., 60-117X Haloid St., Rochester 3, N.Y. Branch offices in principal U.S. and Canadian cities. Overseas: Rank-Xerox Limited, London.

HALOID XEROX®

Circle 501 on Page 19



Get Stepless Adjustable Speed from AC Power

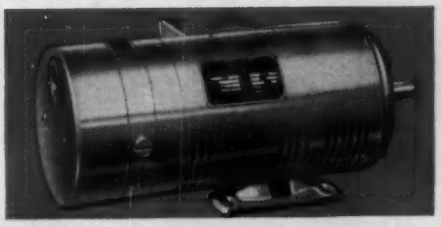
with DYNAMATIC Fractional HP Ajusto-Spede® Drives

Wherever infinite adjustment and accurate control of speeds are required, Eaton-Dynamatic Ajusto-Spede Drives offer a simple, low-cost solution to the problem—stepless adjustment from zero to full output speed, and accurate control of any speed within the speed range.

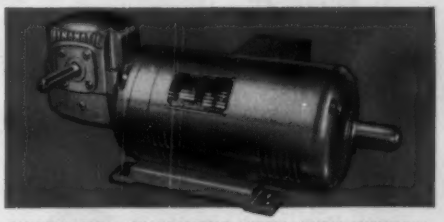
The Dynamatic Ajusto-Spede Drive is an integral combination of AC constant speed induction motor, eddy-current coupling, and plug-in type single-tube electronic control. Torque developed in the motor is transmitted to the driven member by electro-magnetic attraction; there is no mechanical contact between the driving and driven members.

Dynamatic Ajusto-Spede Drives operate on standard 115/230 volt, single phase, 60 cycle or 220/440 volt, 3 phase, 60 cycle alternating current—no special power source is required. Sizes are ¼, ½, and ¾ horsepower at 1600 RPM; ½, ¾, and 1 horsepower at 3200 RPM.

With standard, special, or remotely mounted transistorized control, Dynamatic Ajusto-Spede Drives offer many worthwhile advantages not found in other methods of speed control. Send for illustrated descriptive literature.



DYNAMATIC AJUSTO-SPEDE DRIVE WITH ELECTRICALLY OPERATED BRAKE. With the safety type friction brake, it is possible to achieve rapid deceleration and quick stop, thus providing fast cycling operation.



DYNAMATIC AJUSTO-SPEDE DRIVE WITH INTEGRAL SPEED REDUCER. Because of the variety of gear ratios available in the reducer, this compact assembly is adaptable to a wide range of slow speed applications.

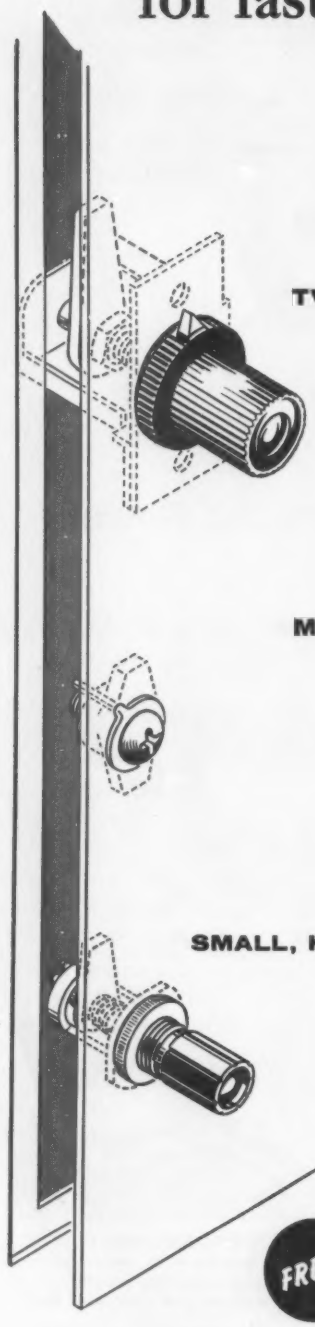
EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

ORIGINATORS OF EDDY-CURRENT SPEED CONTROL EQUIPMENT

Circle 502 on Page 19

Standards with unique features for fastening doors and panels

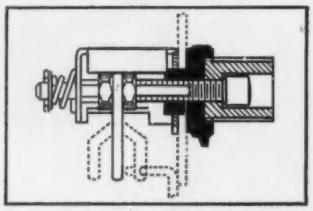


Southco adjustable pawl fasteners are easy and economical to install, give a "class" appearance to equipment. They apply controlled pressure to seal tightly and stop rattles.

TWIN KNOB CONTROL—NO. 46

The pawl engages the frame when the actuator is turned 90°. A bright chrome button in the center of the knob is preset for the amount of pressure to be exerted by the fastener. After the pawl engages the frame, the knob is turned until the button is flush with the knob surface. Preset pressure is thus obtained.

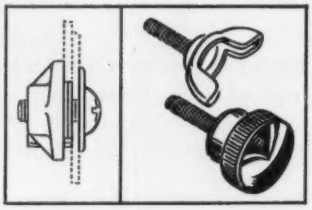
Materials *Body: Cadmium plated steel*
Knob: Black nylon



MINIATURE ENVELOPE—NO. 45

Requiring a minimum of space inside and outside, this fastener latches on a 1/4 turn and additional turning pulls up the door or panel against its frame. The nylon pawl operates smoothly against metal and provides exceptional wearing qualities.

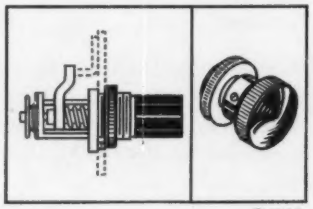
Materials *Pawl stop and washers: Carbon steel, cadmium plated*
Pawl: Nylon, natural



SMALL, HEAVY-DUTY MOUNTING—NO. 48

Small, rugged, compact. One quarter turn closes, additional turning tightens. Quickly installed with a single mounting nut. Three sizes cover every frame thickness from .000 to .750. Can be supplied with flatted shaft for your knob.

Materials *Body and pawl: Steel, cadmium plated*
Knob: Black nylon



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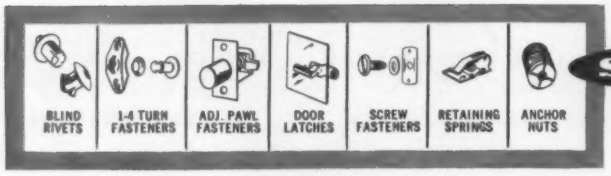
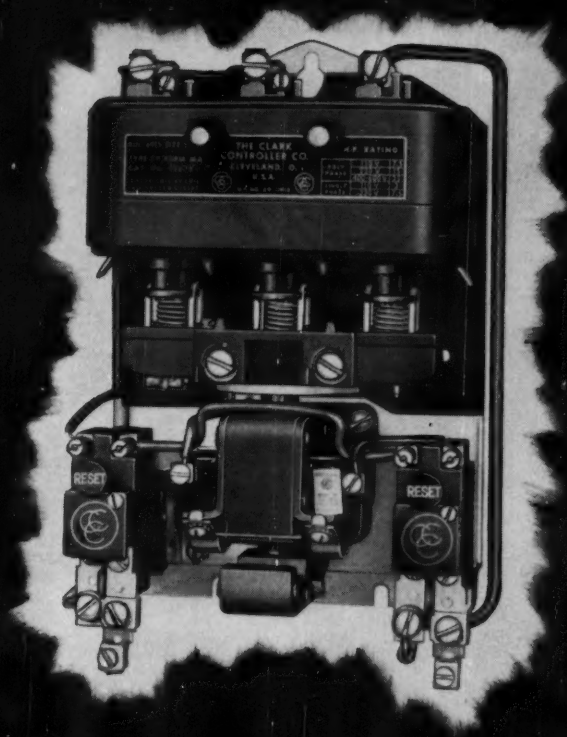
FREE! **Your copy of Southco Fastener Handbook containing engineering data on wide selection of fasteners. Write to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.**



SOUTHCO FASTENERS
LION

What's the measure of starter performance?



COMPARE RELIABILITY

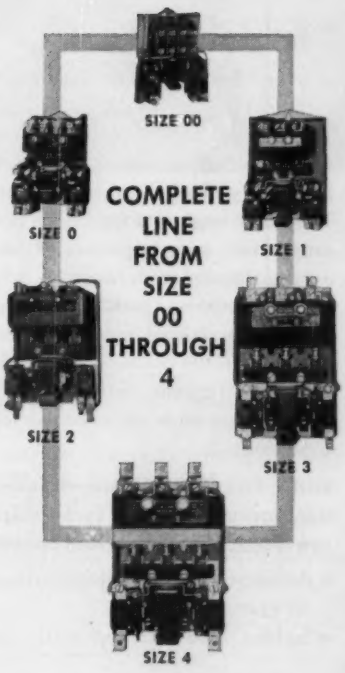
Clark "CY" Magnetic Starters give you more

Buy on proof of performance! Make your own comparison and see how reliable an AC starter can be in the toughest applications you can find. Compare under any operating conditions and you will see why verified user reports underscore the reliability of Clark "CY" design... the performance advantages of "CY" engineering... the care and attention to detail of "CY" manufacture.

Your own comparison will also prove that Clark's rugged AC magnetic starters give you more added safety, service life, ease of installation and economical maintenance. The comparison costs you nothing—the proof can save you money!

Clark Type "CY" AC Magnetic Starters are available in many combinations and in a variety of enclosures to meet every industrial application. Your local Clark distributor or district sales representative will be glad to help you set up your own comparison tests. Ask him for literature on the complete Clark Type "CY" Starter line. Or write direct.

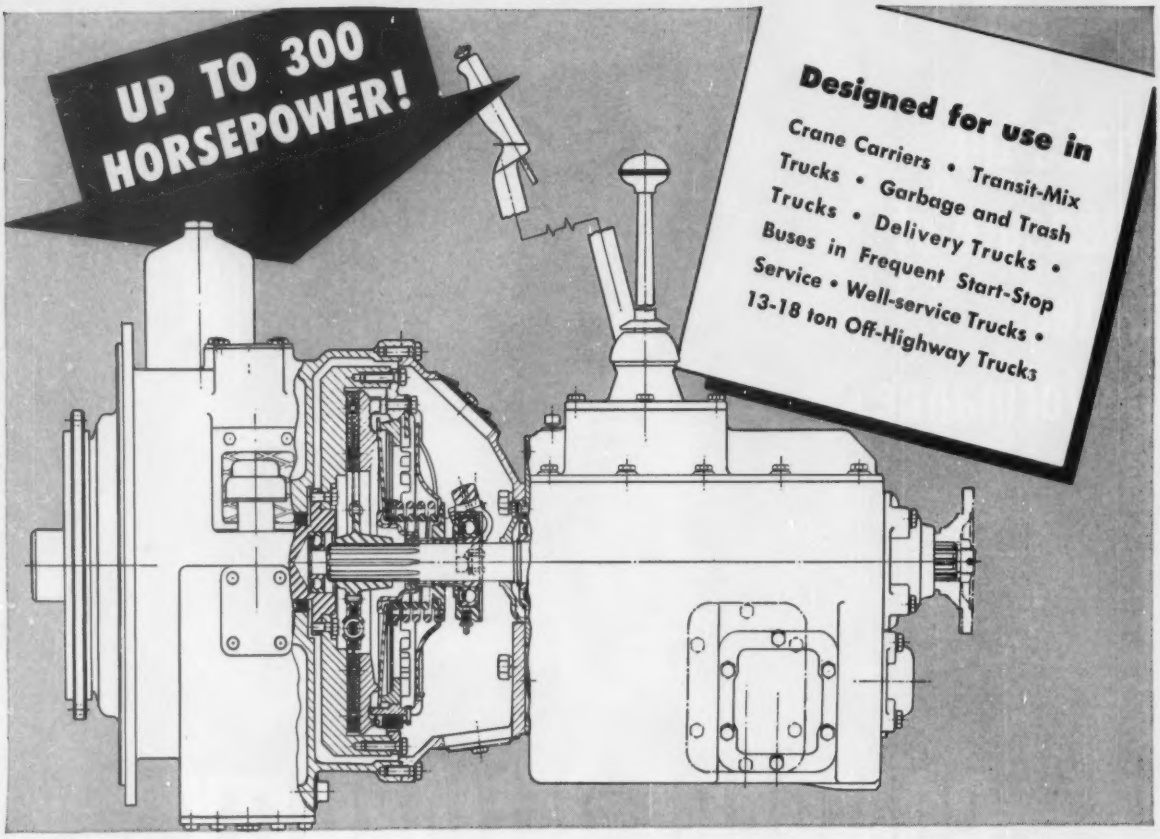
6081



The
CLARK CONTROLLER
"Everything under Control" *Company*

Main Plant: *Cleveland 10, Ohio* • **Western Plant:** *Los Angeles 58, Calif.*
In Canada: *Canadian Controllers, Limited, Toronto*

Circle 504 on Page 19


UP TO 300 HORSEPOWER!
Designed for use in
Crane Carriers • Transit-Mix Trucks • Garbage and Trash Trucks • Delivery Trucks • Buses in Frequent Start-Stop Service • Well-service Trucks • 13-18 ton Off-Highway Trucks

NEW Torque Converter—Transmission Packages from TWIN DISC

- ***Choice of standard mechanical transmissions—Fuller, Spicer or your own design***
- ***Standard mechanical spring loaded clutches—Lipe or Spicer***

Twin Disc's new torque converter-mechanical transmission units are the result of a design project in which Twin Disc engineers worked in close cooperation with engineers of leading transmission manufacturers. What they perfected is a "package" designed to meet specialized power transmission needs—the needs of vehicles engaged in frequent start-stop service or subject to wide variations in load conditions.

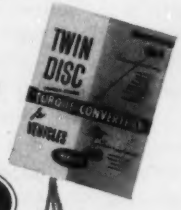
With a Twin Disc converter-transmission package, users of such vehicles can realize these important benefits:

- Automatic torque multiplication in all gear ratios
- Sudden load increases easily handled without shifting gears
- Smooth, effortless starting—engine stalls completely eliminated
- "Fluid cushion" protection throughout the drive train for less downtime, longer life
- Increased driver efficiency because operation is far less fatiguing

The new Twin Disc package offers several advantages over other converter-transmission units. Capacity range is greater—up to 300 hp and 650 lb-ft of torque. Furthermore, Twin Disc permits the user to select the make of transmission he prefers. A third "plus" feature is the fact that Twin Disc uses a standard spring-loaded clutch which provides the familiar "feel" that vehicle operators want.

Twin Disc engineers will be glad to work with you in adapting this converter-transmission package to your vehicle's requirements.

Send for Bulletin 511



TWIN DISC POWER TRANSMISSION EQUIPMENT

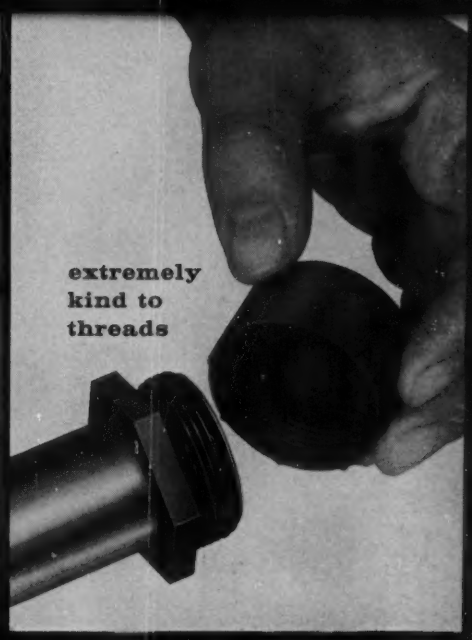
TWIN DISC

Torque Converters

TWIN DISC CLUTCH COMPANY
RACINE, WISCONSIN
HYDRAULIC DIVISION, Rockford, Illinois

Circle 505 on Page 19

can save you hundreds $$$
for pennies spent



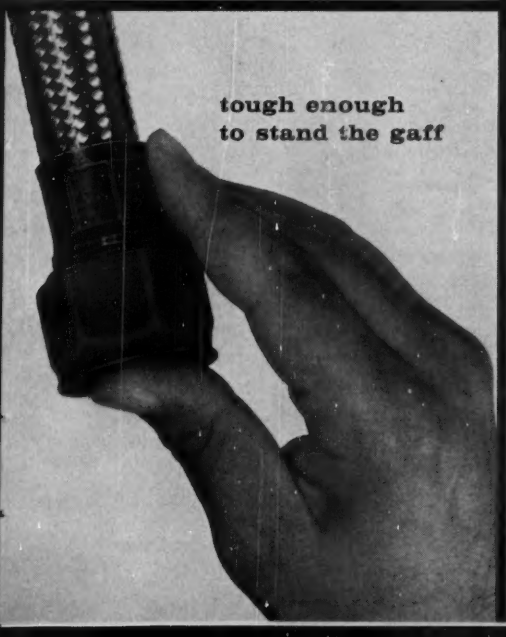
extremely
kind to
threads

easy to apply
...and remove

molded of flexible
Polyethylene

Caplugs

now in stock: over
600 sizes in numerous
styles and colors.



tough enough
to stand the gaff

won't chip,
break, shred
or collapse

snug-fitting closures to meet almost any need you can name... get a kit full of samples in exchange for the coupon below.

Circle 506 on Page 19

CAPLUGS DIVISION,
PROTECTIVE CLOSURES CO., INC.
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MAIL a free assortment of Caplugs literature and prices to us, without obligation.

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Title

Firm

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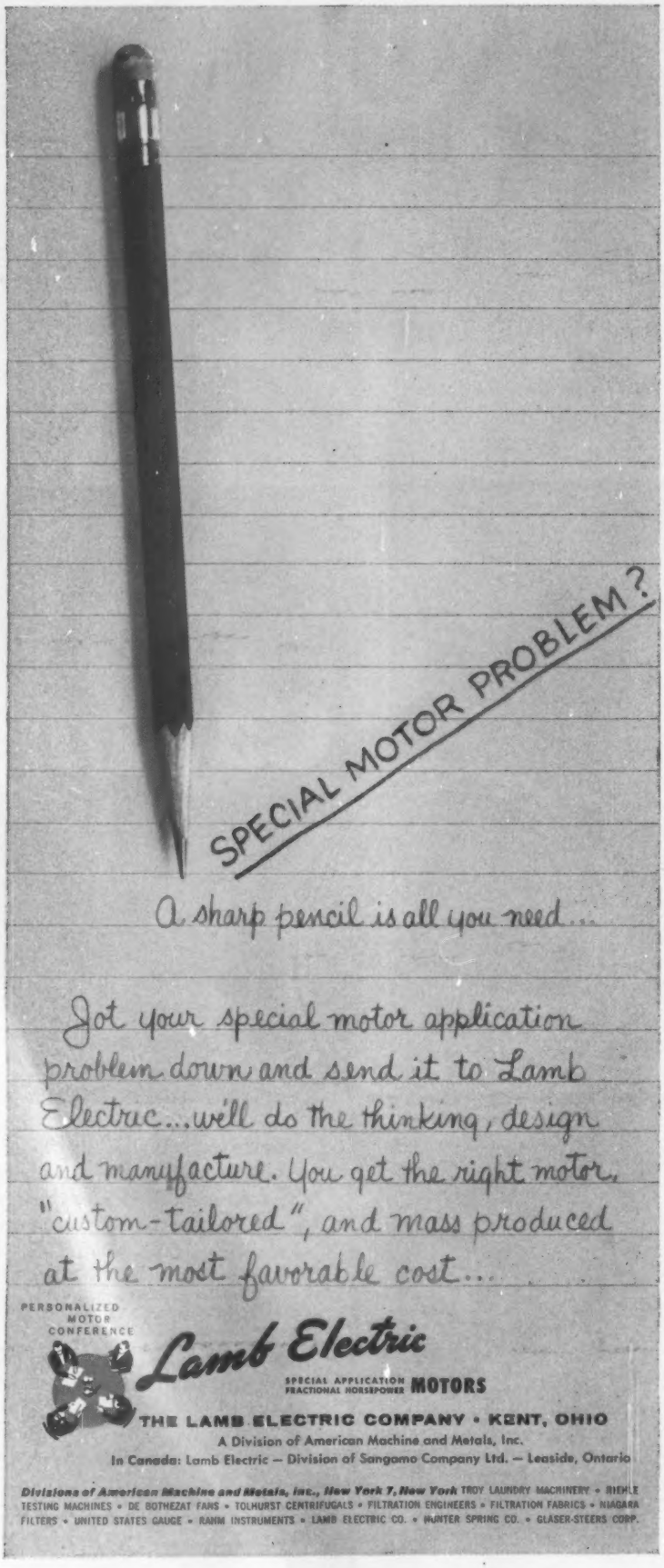
City Zone State


SPECIAL MOTOR PROBLEM?
A sharp pencil is all you need...
Jot your special motor application problem down and send it to Lamb Electric...we'll do the thinking, design and manufacture. You get the right motor, "custom-tailored", and mass produced at the most favorable cost...
PERSONALIZED MOTOR CONFERENCE
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SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS
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A Division of American Machine and Metals, Inc.
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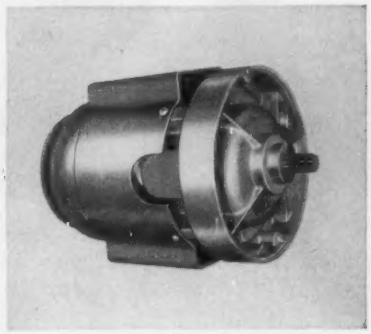
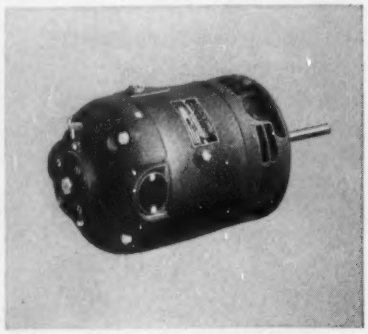
Divisions of American Machine and Metals, Inc., New York 7, New York TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS • NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC CO. • HUNTER SPRING CO. • GLASER-STEERS CORP.

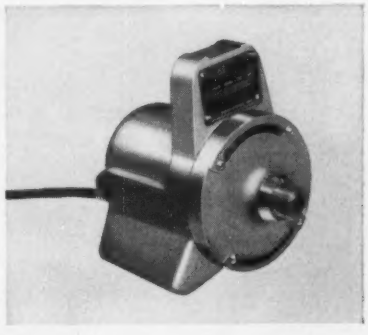
Special Application Fractional Horsepower Motors



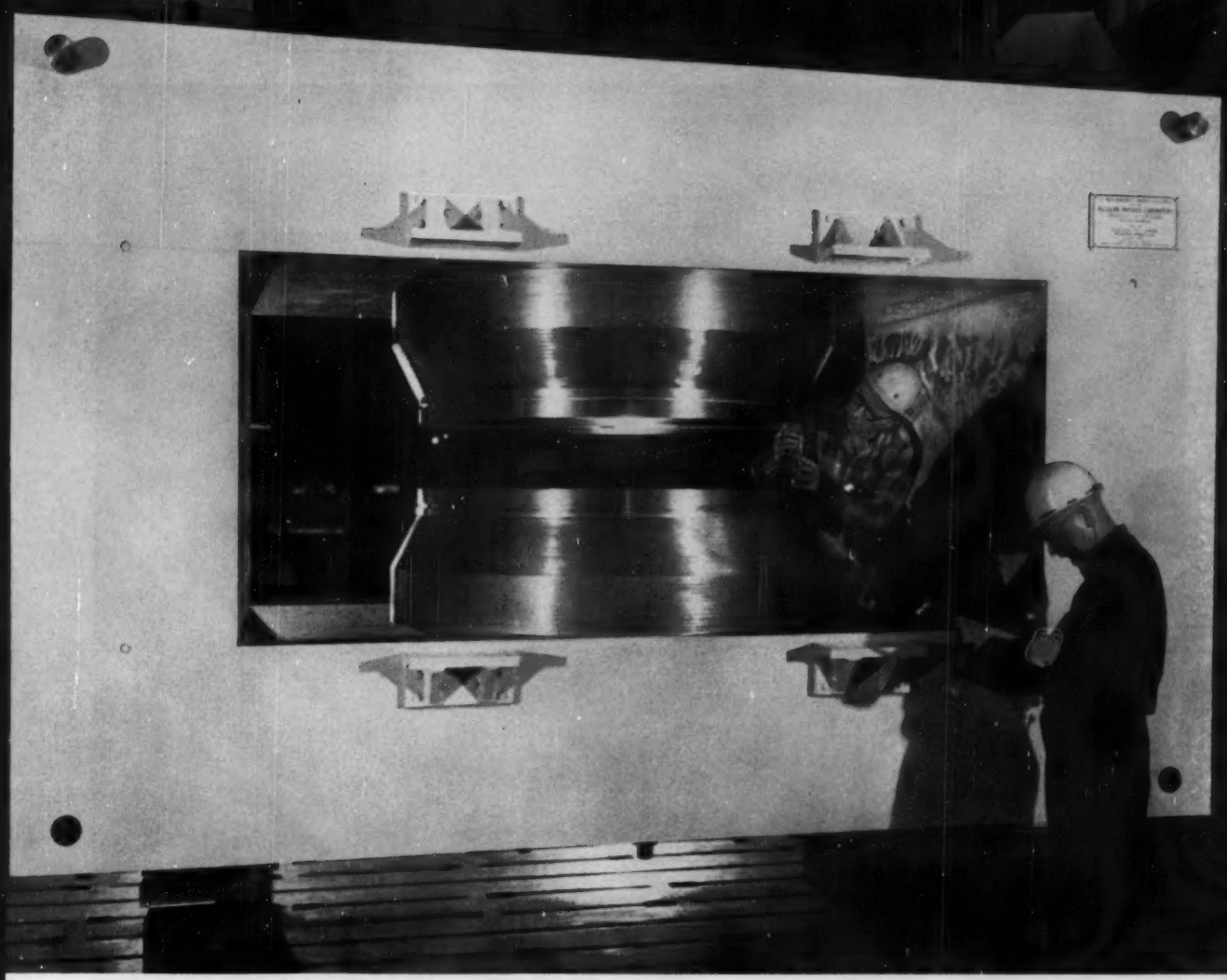
Explosion-proof motor, totally enclosed and fan-cooled. Excellent for high pressure grease guns. Frame: $3\frac{11}{16}$ x $2\frac{1}{4}$. **Lamb Electric Company,** Kent, Ohio.



For industrial vacuum cleaners, colloid mills, hoists, etc. Heavy duty motor, 6 x $2\frac{1}{2}$ frame. **Lamb Electric Company,** Kent, Ohio



Heavy duty industrial quality motor for portable concrete vibrator. Frame: $4\frac{3}{8}$ x $2\frac{1}{2}$. **Lamb Electric Company,** Kent, Ohio.



BETHLEHEM INSPECTORS measure the magnetic gap between the pole pieces of a magnet for the new University of Colorado cyclotron.

85-ton magnet for new research cyclotron forged, machined, and assembled by Bethlehem

The core of a new research cyclotron to be installed by the University of Colorado at Boulder is that 85-ton magnet you see above.

To make this magnet accurate and controllable, Bethlehem had to finish the huge magnet parts to thousandths and to micro-inch finishes. Most critical were the pole tips, which had to be machined to parallelism within 0.004 in. on the 52-in. diameter. They were machined a few thousandths oversize, then the final fitting and machining was done.

The forged pole pieces are tapered on the sides from 59 to 52 in. on the diameter, and are 14.4 in. thick. The yoke members, four of them, were forged in a 7500-ton hydraulic press, then machined to 250-micro-in. with mating surfaces finished to 125 micro-in. They weigh 73 tons, and are held together by large dowel pins and studs. They form a rectangular yoke assembly 142½ in. long, 60 in. wide, and 88½ in. high. The opening measures 96 by 42 in.

When completed, the Boulder cyclotron, a strong-focusing type, will have a capacity range of 10 to 30 million electron volts. The electrons will strike a target when their final speed is built up to 1/8 the speed of light.

Bethlehem Steel Company, Bethlehem, Pa. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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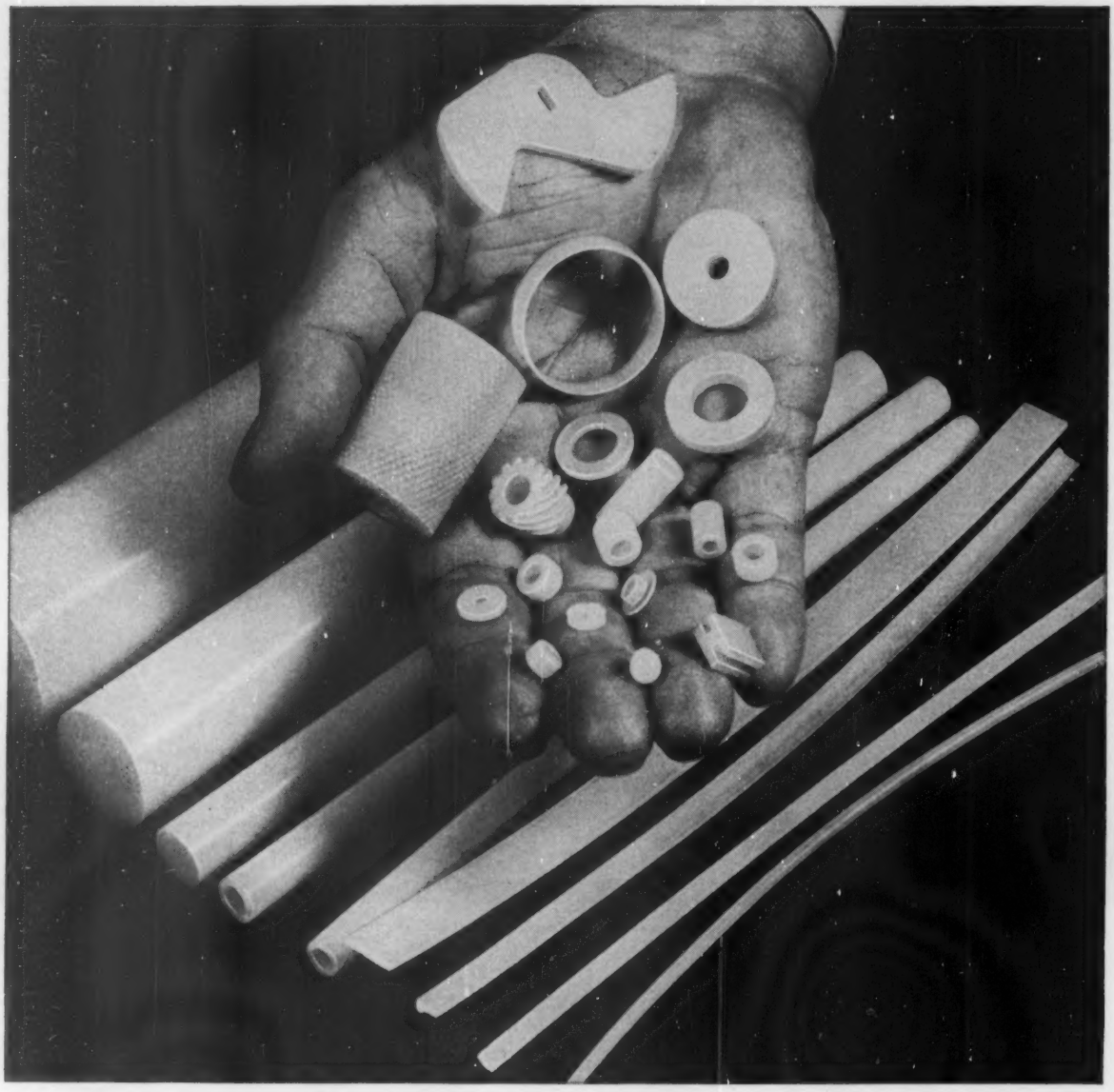


Designers who look to Nylon look to NATIONAL first

For fabricated parts—or for extruded strip, rod, tubing or special shapes—you'll find National a dependable primary source of Nylon. Costly molds and time delays may favor the delivery of 100% usable parts fabricated from National Nylon and timed to your production needs.

In many cases, fabricated parts from standard or special extruded shapes give you more design freedom at no greater unit cost. Buying from the source makes this possible. Before you "freeze" a molded design, talk with your National Sales Representative.

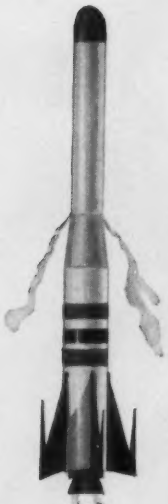
Check him, also, for your other basic materials needs—PHENOLITE® Laminated Plastic, Vulcanized Fibre, PHENOLITE Copper-clad. Many grades from the more than 100 available—including Nylon rod—are "in stock" for immediate shipment. For Nylon sizes, grades and properties, write Dept. G-11, for our Technical Data Folder.

NATIONAL VULCANIZED FIBRE CO. WILMINGTON 99 DELAWARE

In Canada: NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

Circle 509 on Page 19

COUNTDOWN at PESCO



The "Countdown at Pesco" begins in laboratories far from the launching pads. It begins with teams of resourceful Pesco engineers . . . men of vision eminently qualified to meet the technical challenges and rigid reliability requirements of the aerospace industry. All Pesco products shown at right are now critical components of operational air weapon systems. These components are the products of Pesco's advanced engineering that anticipates the sophisticated requirements of the industry . . . plus Pesco's proven capacity for precision production to meet customer delivery schedules. Investigate Pesco's capabilities before you specify on your next project.

PESCO PRODUCTS DIVISION
BORG-WARNER CORPORATION
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EXPORT SALES: Borg-Warner International Corporation
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8 CRYOGENIC PUMPS

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1 SERVO VALVES

SEE IT NOW!
COUNTDOWN AT PESCO

This new 20-minute full color film enables you to evaluate firsthand Pesco's research, development and production capabilities.

Contact your nearest Pesco Sales Office or write direct for private showing.

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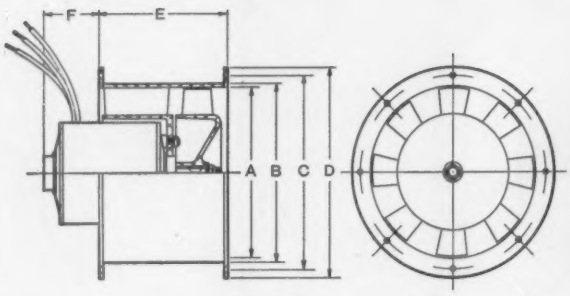
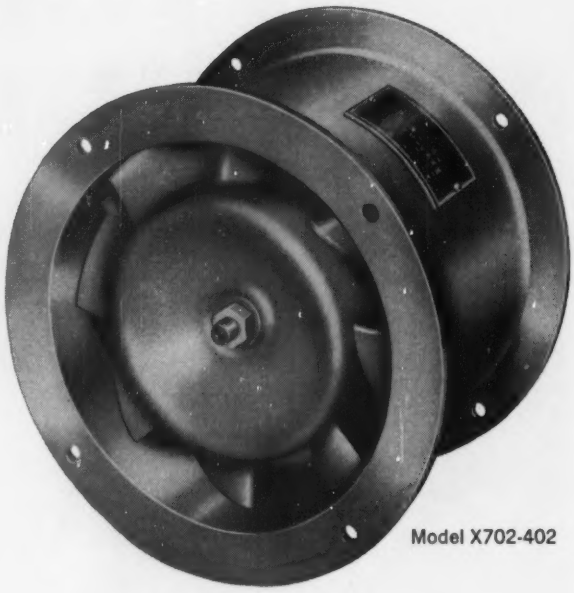




Model X702-402

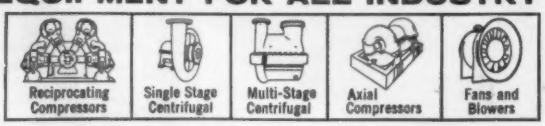
A Complete New Line of Electronic Cooling Fans JOY Axivane Series 60

Developed by Joy specifically for 60 cycle commercial duty, the Series 60 vaneaxial fans operate at 3400 rpm, 115 volts, single phase, 50/60 cycles and produce from 50 to 500 cfm at static pressures of ¼" through 1" wg. They are extremely compact and ruggedly built of anodized aluminum. There are only three major parts; rotor, housing and motor. Production quantities are available on order and small quantities are immediately available off-the-shelf. Get complete information by writing for bulletin 2518-64B.

Model No.	Design CFM ±3%	Max. CFM at Free Flow	Design PS ±7%	Max. Pressure	Motor Data		Mechanical Dimensions (Inches)						Holes Per Flange	Total Weight Pounds
					BHP	CAP* MFD	A	B	C	D	E	F		
X702-401	50	70	0.35	0.45	.005	NONE	4.37	4.62	5.25	5.87	4.50	1.00	4	5.25
X702-402	100	145	0.35	0.60	.010	NONE	5.12	5.37	6.00	6.62	4.50	1.00	4	5.85
X702-403	150	205	0.35	0.80	.015	NONE	5.62	5.87	6.50	7.12	4.50	1.00	4	6.1
X702-404	200	265	0.50	0.79	.035	5	5.62	5.87	6.50	7.12	5.00	1.66	8	7.2
X702-405	250	330	0.50	0.82	.043	5	5.87	6.12	6.75	7.37	5.00	1.66	8	7.4
X702-406	300	410	0.50	0.93	.052	5	6.12	6.37	7.00	7.62	5.00	1.66	8	7.6
X702-407	350	490	0.50	0.95	.060	5	6.37	6.62	7.25	7.87	5.00	2.16	8	8.4
X702-408	400	590	0.50	1.07	.068	5	6.62	6.87	7.50	8.12	5.00	2.16	8	8.6
X702-409	450	650	0.50	1.05	.075	5	6.87	7.12	7.75	8.37	5.00	2.16	8	8.8
X702-410	500	735	0.50	1.15	.083	5	7.12	7.37	8.00	8.62	5.00	2.16	8	8.9

*Rated 236 WVAC—

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

Circle 511 on Page 19

FALK and STEELFLEX are Registered Trademarks

Cut disconnect-reconnect time by as much as 50%

The FALK Spacer Coupling is specially designed for quick installation or removal *without disturbing the driving or driven unit.* This feature can save you up to 50% in disconnect-reconnect time when critical equipment—a process pump, for example—needs repair or replacement.

Here's another saving: with the FALK Spacer Coupling, you can quickly realign shafts *without the usual loss of operating temperature!*

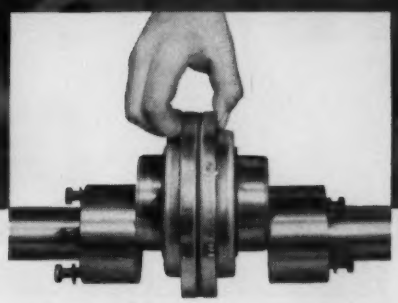
And still another: you can remove or reinstall the FALK Spacer as a unit *without draining the lubricant.*

Because of its exclusive grid-groove Steelflex design, the FALK Spacer can accommodate residual misalignment—parallel, angular, or (most important) *both.* Also, it provides torsional resiliency that cushions shock and vibration. Thus it saves wear-and-tear on your connected equipment.

To prove these claims and enjoy these savings, install a FALK Spacer on one application—and see for yourself. Consult your FALK Representative or Authorized Distributor.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS
Representatives and Distributors in many principal cities.

Circle 490 on Page 19

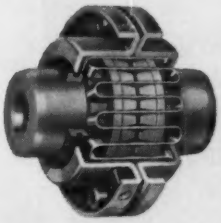


EASY AND QUICK TO INSTALL, DISCONNECT OR RECONNECT

First, mount shaft hubs to allow proper distance between hubs; then, align driving and driven units.

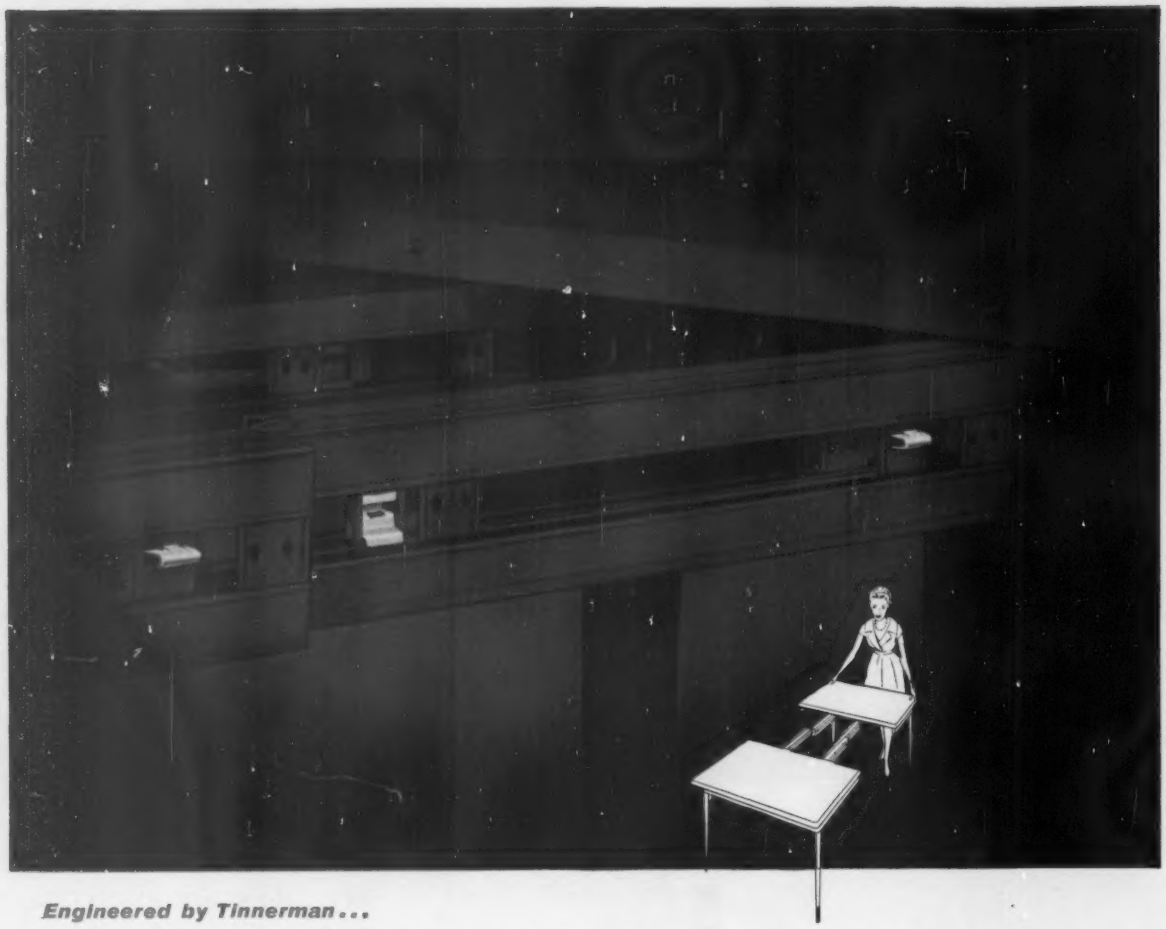
Second, compress Spacer to fit space between hubs and tighten cap screws to pull spacer hubs into the registered fit.

To disconnect, reverse the second step. No draining of lubricant necessary.



The heart of the FALK Spacer ...the basic Type F Steelflex
Write for Service Manual 4838

FALK
...a good name in industry



Engineered by Tinnerman...

SPEED CLIP® replaces three parts on table-slide ...rate of assembly increased by 50%!

New all-steel nonbinding slides made by Watertown Table-Slide Company are now assembled faster, better! One Tinnerman SPEED CLIP replaces three separate parts used in earlier designs and produces double-header savings for Watertown.

This special spring steel SPEED CLIP holds the slides together firmly, yet lets them slide easily without binding. One quick stroke with an ordinary mallet seats and locks the SPEED CLIP in place. Long service life without loosening or sagging is assured.

Savings and assembly advantages like these are possible on your product too. Call in your Tinnerman representative and let him show you how. He can acquaint you with the 10,000 variations of SPEED NUT Brand Fasteners bringing similar benefits to manufacturers everywhere. He can also arrange for a FASTENING ANALYSIS of your product. This no-charge service has saved industry millions of dollars. Why not see what it can do for you? Tell us when you would like to have him call.

TINNERMAN PRODUCTS, INC.
Dept. 12 • P.O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

MACHINE DESIGN
November 10, 1960

More Pressure, Less Heat

A BUSINESS is like a gas turbine. Income is the power developed at the turbine wheel. Expenditure is the power absorbed by the compressor. You can't have one without the other, and profit is the difference—the usable jet or shaft horsepower.

Even successful businesses (and turbines) require expenditures almost as high as income—but not quite. It's the margin that counts.

Corporate management's collective blind spot is failure to recognize the almost equal contributions of spenders and of income producers in determining profit margin.

Salesmen are rewarded by suitable incentives for efforts that affect income. But engineers are not often similarly rewarded for reducing costs.

It is as if a design engineer lavished all his attention on the turbine wheel and took the compressor for granted. But any designer worth his salt knows that nothing eats up expensive power faster than an inefficient compressor.

Wise management, likewise, knows that a neglected engineering staff can have as much adverse influence on profit as a poor sales crew.

A poorly designed compressor generates excess heat—expensive heat from the irreversible conversion of mechanical work. A neglected engineering staff also generates excess heat—random energy, too—of the sort that leads to collective bargaining.

Like the turbine designer, management wants maximum pressure with minimum heat. A close look at our current series of news articles on engineering unionism should help management recognize some factors that affect such performance. It should also help engineers decide whether pressure or heat is most likely to earn favorable recognition by management.

Colin Carmichael

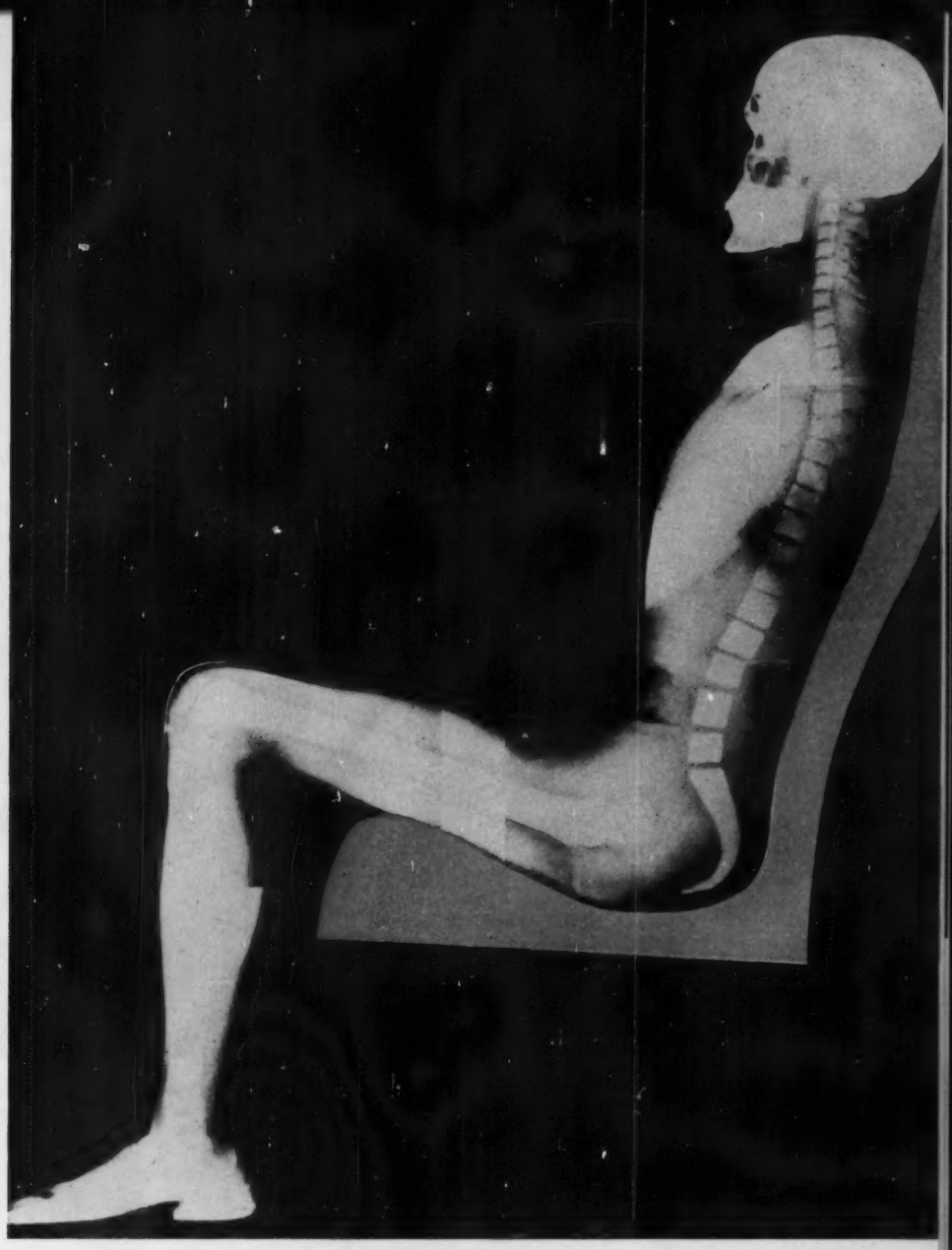
EDITOR

TAKE A SEAT . . .

any seat, in a tractor, truck, or earthmover, and chances are it is a key factor in operator efficiency. Here are ten rules for more effective design of

seats for people

Lockheed Jetstar aircraft seat—designed according to the principles of good seating.



HENRY DREYFUSS, South Pasadena, Calif.

WHAT makes a seat comfortable? Why do seats that create a good first impression become uncomfortable in such a short time? How can comfortable seating be designed or selected?

An ideal seat should provide restful packaging of the occupant after many hours of sitting. Ample proportions of the seat bottom and arm rests contribute to the first impression. Additionally, as the occupant sits down, the seat should produce a feeling of softness, together with a sensation of sinking down slowly rather than of striking bottom.

In addition to the usually recognized five senses, all humans have an additional sixth sense known as the proprioceptive, or position, sense. This sense is the one which registers muscular fatigue and discomfort. Since it is the most important sense in relation to comfort during prolonged seating, it is the one which governs the principles of good seating.

Occupant Size: The most common complaint about seats is that they do not fit properly. In most ve-

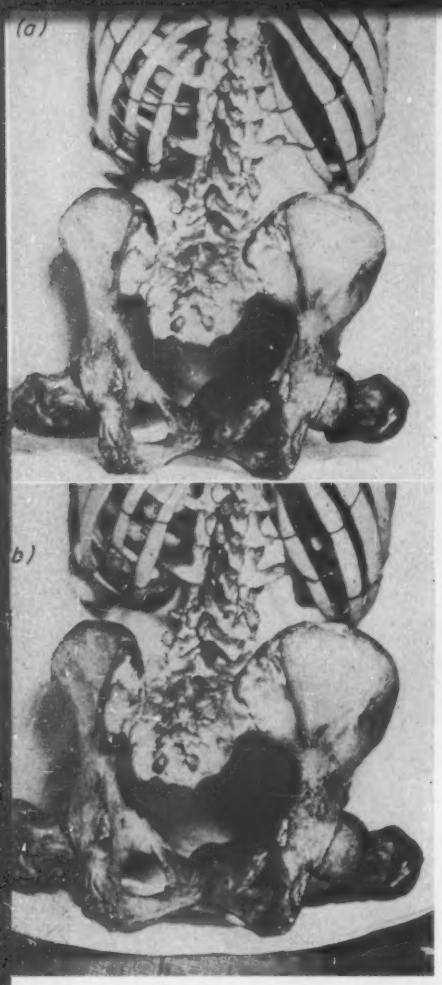


Fig. 1—Left—A flat, firm seat bottom supports the pelvic bones properly, Fig. 1*a*. The undesirable bucket-seat arrangement transfers a portion of the body weight to the thigh-joint bones, Fig. 1*b*.

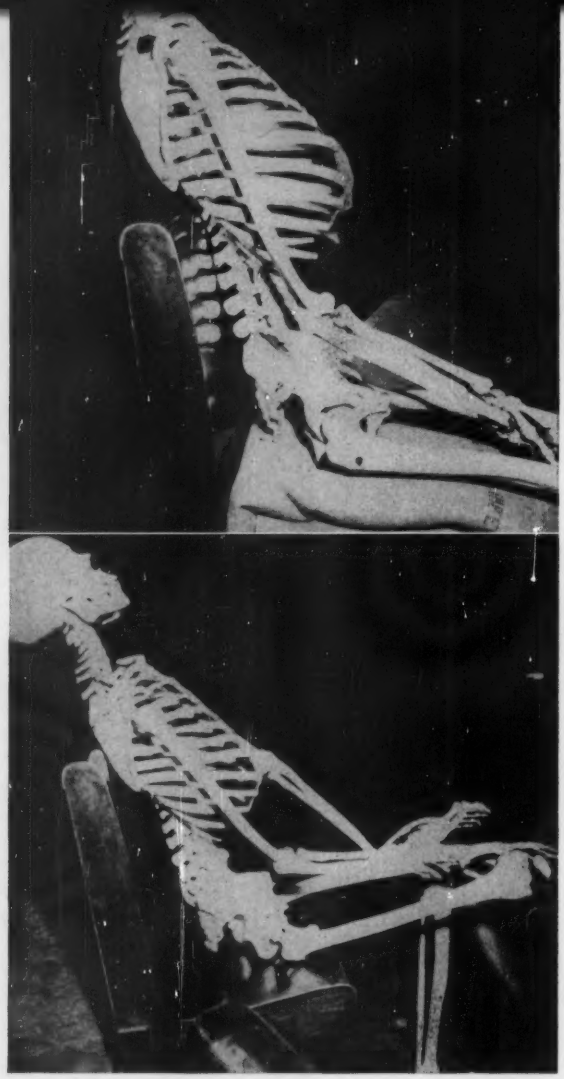


Fig. 2—A short back rest at the proper height provides support that is better than a slightly higher, but improperly shaped, back rest.

seats for people (continued)

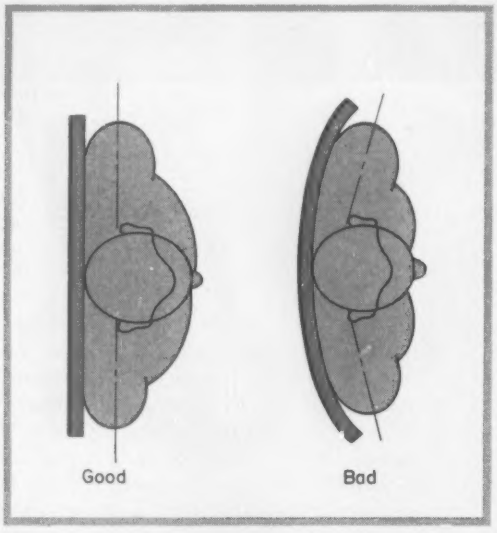


Fig. 3—Shoulders should rest against a reasonably flat surface. If the back rest is too concave, the shoulders are rolled inward, impairing breathing efficiency and producing fatigue.

hicles, the tall person complains of lack of leg room between and under seats. The short person suffers largely from underthigh pressure caused by seat bottoms that are too deep, too high, or too steeply pitched.

Cushion Configuration: When seated, the human body is best supported if most of the weight rests on the two bony points of the pelvis, Fig. 1*a*. These points, roughly 4½ in. apart, are rich in arterial blood vessels and can take a great deal of pressure with a minimum of discomfort. To concentrate the seated body's weight on these two points, a seat cushion must be flat and firm, Fig. 1*a*.

If the seat surface is curved from side to side, as in a bucket seat, part of the weight-bearing function of the pelvic bones is transferred to the thigh-joint bones. This rolls the thighs inward which, in turn, produces abnormal muscular tension and low-back discomfort during prolonged seating.

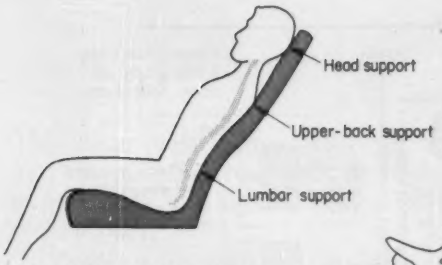


Fig. 4—Tilting the seat back helps relieve the muscles of the normal job of support. Exact angle required varies with the seat type.

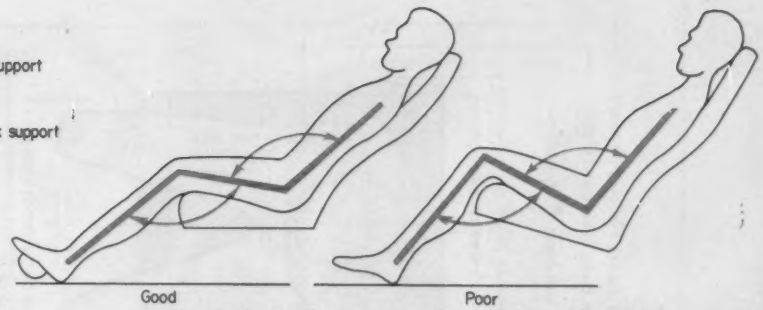


Fig. 6—Angles between the hips and knees should be at least 90 deg. These angles should be maintained even if the occupant is seated in a more nearly upright position.

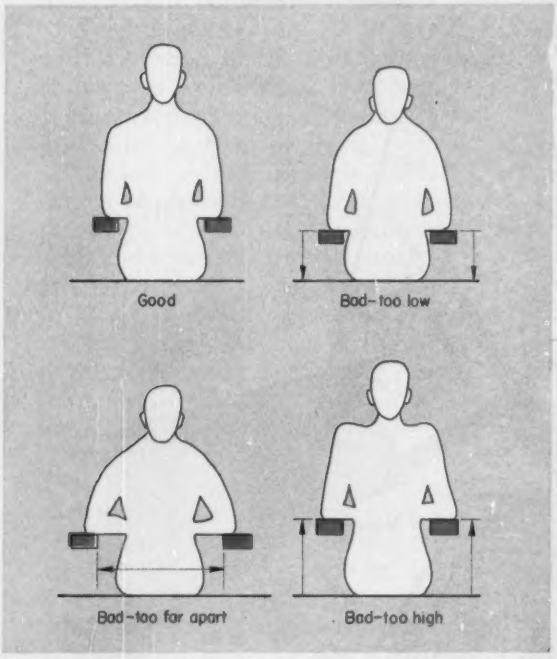


Fig. 5—Arm rests must be correctly located if they are to be of any value.

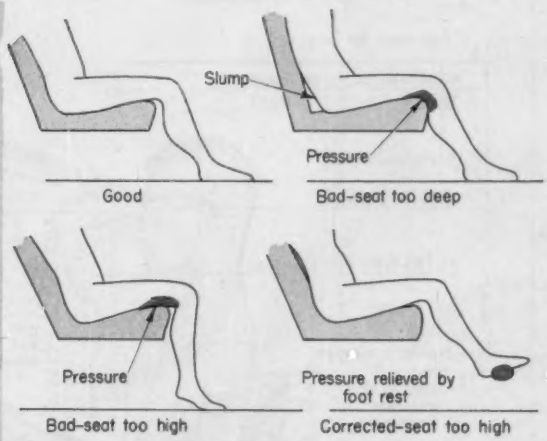


Fig. 7—Seat height, pitch, and length should be adjusted to prevent excessive pressure on the thighs.

However, the flat seat surface should not be hard. Rather, it should be just soft enough to allow limited deformation of the cushion in the area in which the pelvic bones bear the weight. The shock-absorber effect of coil springs or deep cushioning should be obtained by the use of resilient material under the rigid platform within the seat bottom.

Lower-Back Support: A good seat follows the inward curve of the lower back or lumbar region, Fig. 2. It relieves the lower back muscles of the tiring job of holding the trunk upright. For comfortable support, the lumbar contouring should be curved slightly in the horizontal plane to follow the normal rounding of the back. However, the seat back should not be curved enough to restrict freedom of movement.

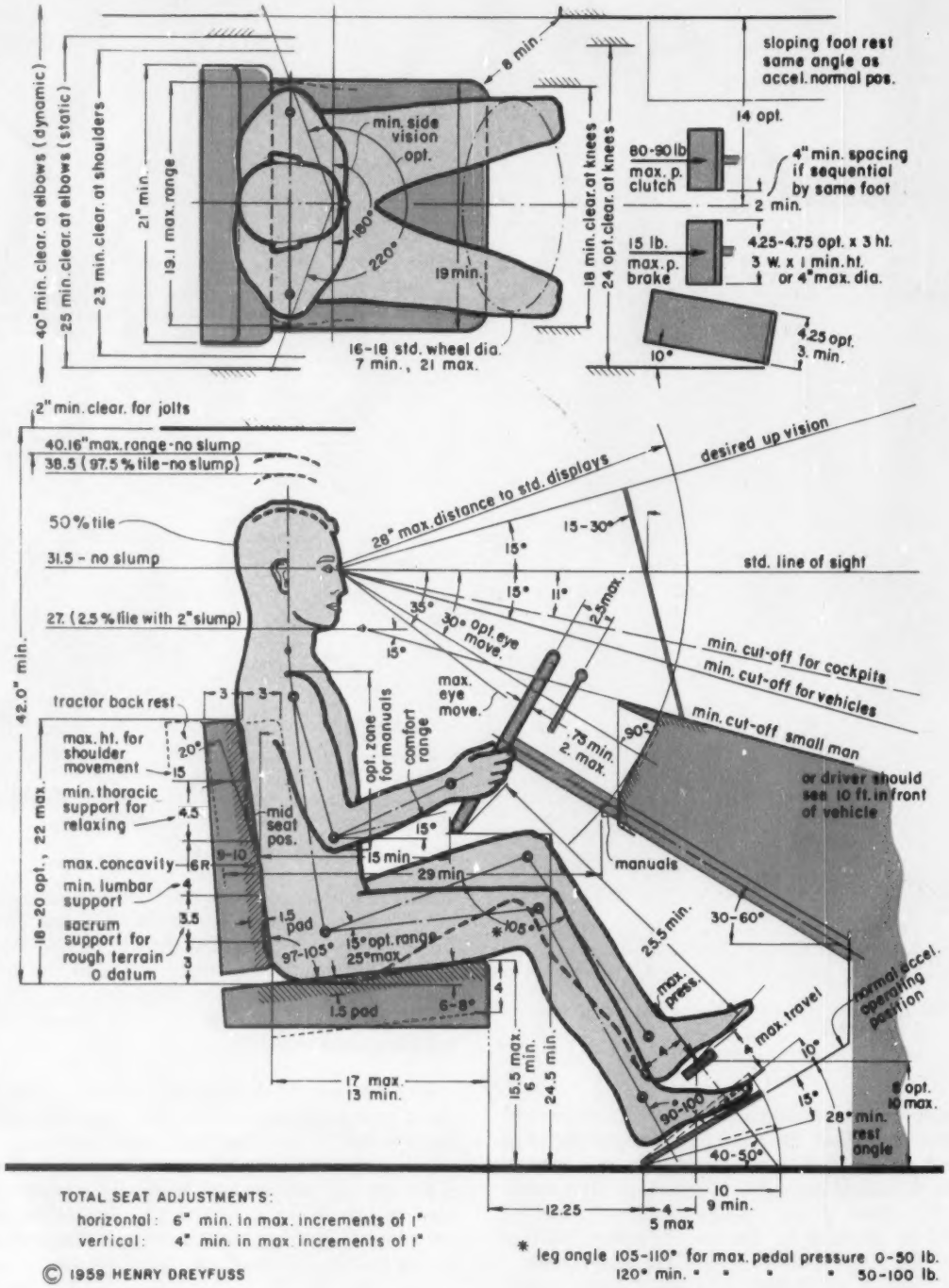
Upper-Back Support: A properly designed seat maintains normal good posture. The seat has enough tilt to throw the chest gently outward and allows the shoulders to drop back slightly. The seat should support the middle and upper region of the spine, Fig. 3. However, the scoop-back type of support should be avoided because it rounds the shoulders and compresses the chest.

Shoulder and Neck Support: Ideally, a well-designed seat back supports not only the upper back, but also the shoulder and neck muscles.

However, contouring the seat back to fit the nape of the neck is not practical because the contouring must be placed at exactly the right height for each individual. Therefore, this portion of the seat assembly must be adjustable by the occupant.

Seat-Back Slope: The seat bottom and back should be angled to tilt the entire body back, Fig. 4. This tilt may be slight. A work seat needs less than a lounge chair, but it must be enough to relieve the muscles of their normal job of support. The slope allows the seat to do the supporting.

Upper-Body Support: Arm rests are valuable only if they help the elbows support some of the weight of the upper body, Fig. 5. Too often these rests are placed too low or too far apart, forcing the occupant



Critical dimensions in seating an adult male operator on mobile equipment. (Chart from **The Measure of Man** by Henry Dreyfuss to be published by Whitney Library of Design, New York.)

to slouch when using them. Or, they may be too high, forcing him to hunch his shoulders.

The under surface of the arm rest should be cut back to provide clearance for the hips and thighs between the seat cushion and the under surface of the arm rest.

Angle of Hips and Knees: All comfortable seating postures have one thing in common—they maintain an angle of at least 90 deg between the hips and knees, Fig. 6. Angles of less than 90 deg cause jackknifing—the painful effect of having knees forced toward the chest by sagging seats, too little leg

Aircraft Seat Dimensions

The dimensions shown are based in part on variation in body size as determined by measurement of nearly 4000 people.*

Height of the men ranged from 59 to 80 in., with a median of 69 in. Height of women ranged from 55 to 73 in., with a median of 64.9 in.

The 31 in. seat back height accommodates tall persons.

Weight ranged from 70 to 309 lb, with a median of 152.8 lb. However, 95 per cent weighed 207 lb or less.

Hip breadth ranged from 12 to 21.3 in., with a median of 15 in.

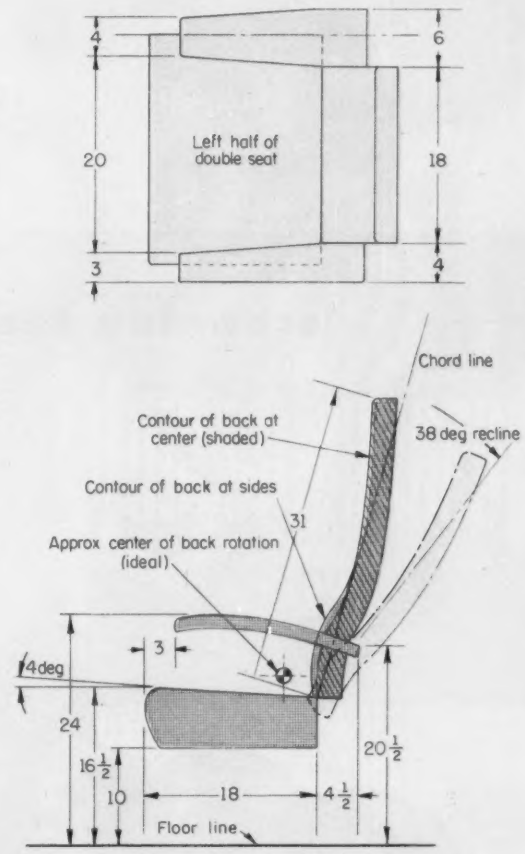
The seat width of 20 in. is ample for change of position, and accommodates persons of unusually wide hip breadth.

Shoulder breadth ranged from 12.7 to 22.4 in., with a median of 16.9 in. In 95 per cent, it was 18.8 in. or less.

Distance from the tip of the elbow to the compressed seat surface ranged from 8 to 11 in. with a median of 9.6 in.

Measurements on another group indicated that the maximum concavity of the lumbar region ranged from 8 to 12 in. above the depressed seat cushion and extended over a 5 in. range in the vertical direction.†

The seat back is contoured vertically with maximum convexity at about 10 in. above the depressed seat cushion to maintain the normal lumbar curve, when reclining on the back. Contouring also supports the flank region when reclining on the side.



*A. Hooten—"A Survey in Seating," Haywood-Wakefield Co., Gardner, Mass., 1945.

†G. Wedell and H. D. Darcus—"Some Anatomical Problems in Naval Warfare," *British Journal of Industrial Medicine*, April, 1947, pp. 77-83.

room, or poorly sloped seat bottoms and backs.

Minimum Pressure on Thighs: If the front edge of the seat exerts undue pressure, the feet and legs become numb because of pinching of the nerves, Fig. 7. Excessive underthigh pressure can be avoided by correct seat height at the front so that the weight of the lower legs and feet is borne fully by the floor, by a seat bottom that is not too soft in the center in relation to the front edge, and by a seat bottom that is not pitched backward without corresponding elevation of the feet or lowering of the seat height at the front.

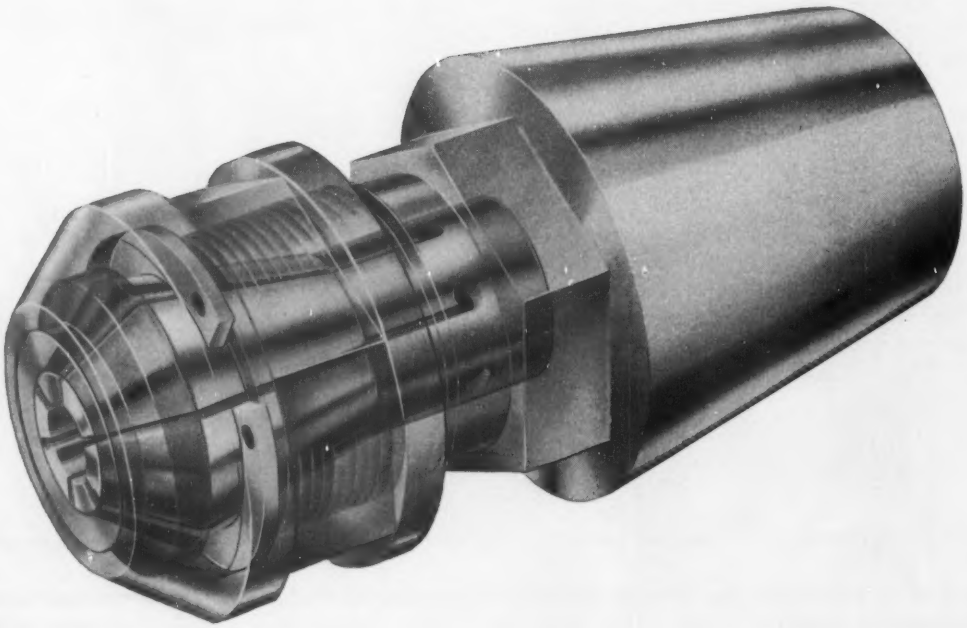
The seat depth should be as short as other comfort factors will permit. Thus, the danger of compression of the soft tissue by a too high or too steeply pitched seat bottom will be reduced.

Position Variation: No one position, no matter how comfortable it is at first, remains comfortable for very long. A good seat allows many comfortable postures—the more the better. The popular contour-chair concept violates this principle. It allows one comfortable position, but severely limits the number of others.

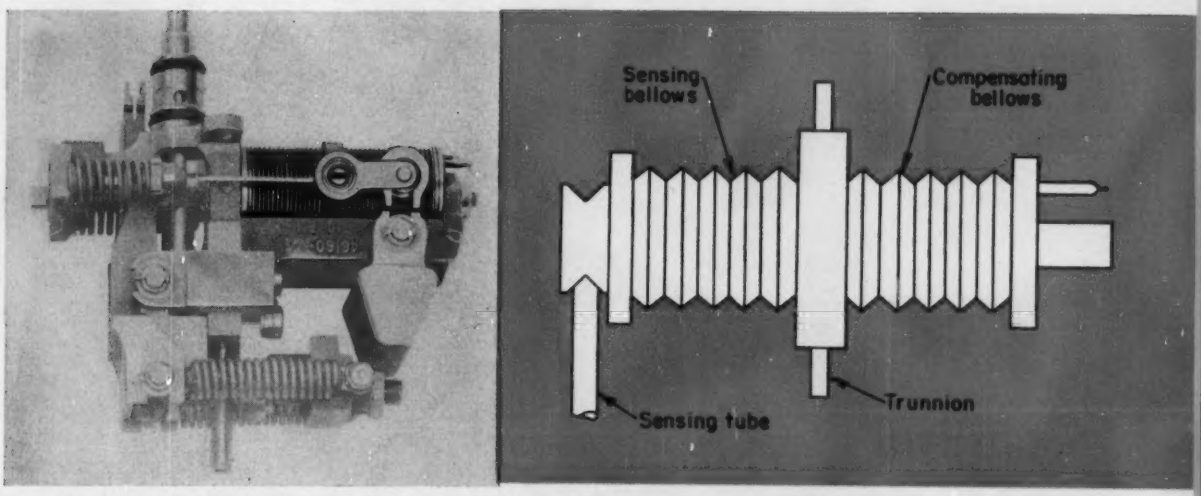
The seat must be large enough to allow variety of positions. If arm rests enclose the sides of the seat, the width of the seat bottom must be ample.

A slight forward-and-backward rocking movement in response to shifts of body weight provides an automatic change in body angles and prevents muscular tension and fatigue. This movement can be provided by the compressibility of the padding in the seat bottom or by an adjustable seat back.

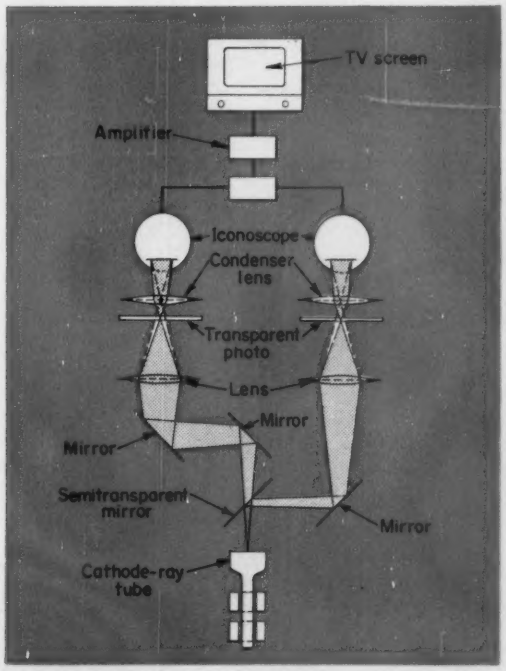
scanning the field for *ideas*



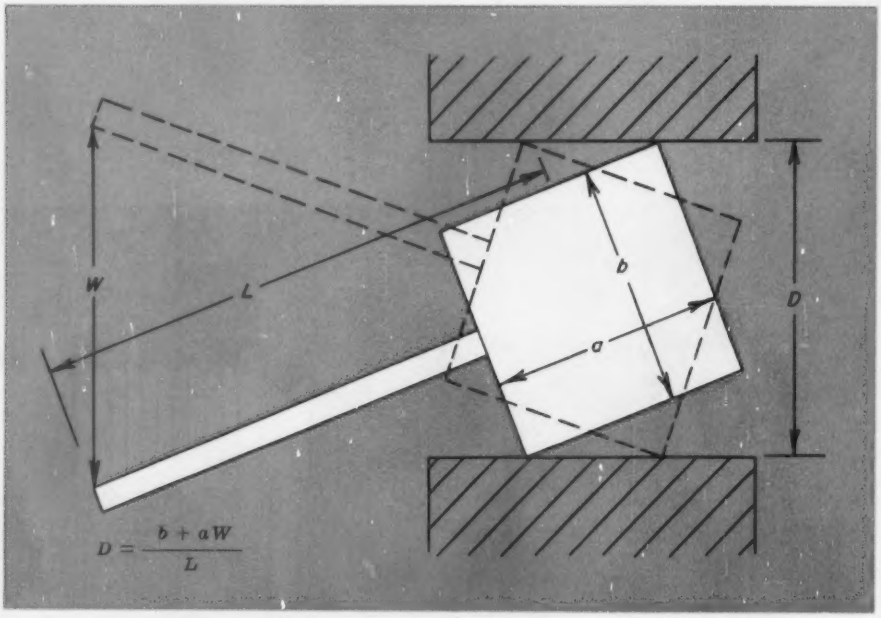
Ring-released jaws produce positive opening and grip in a milling-machine collet. Screwing the nut onto the adapter forces the outer ring against the short taper, compressing the jaws. To release, the nut is backed off, forcing the ejector ring against the long taper. This pulls the collet from the mating taper in the adapter, permitting the jaws to spring open and release the tool. Automatic releasing principle employed in collet developed by Chi-Co Inc., Northfield, Ohio.



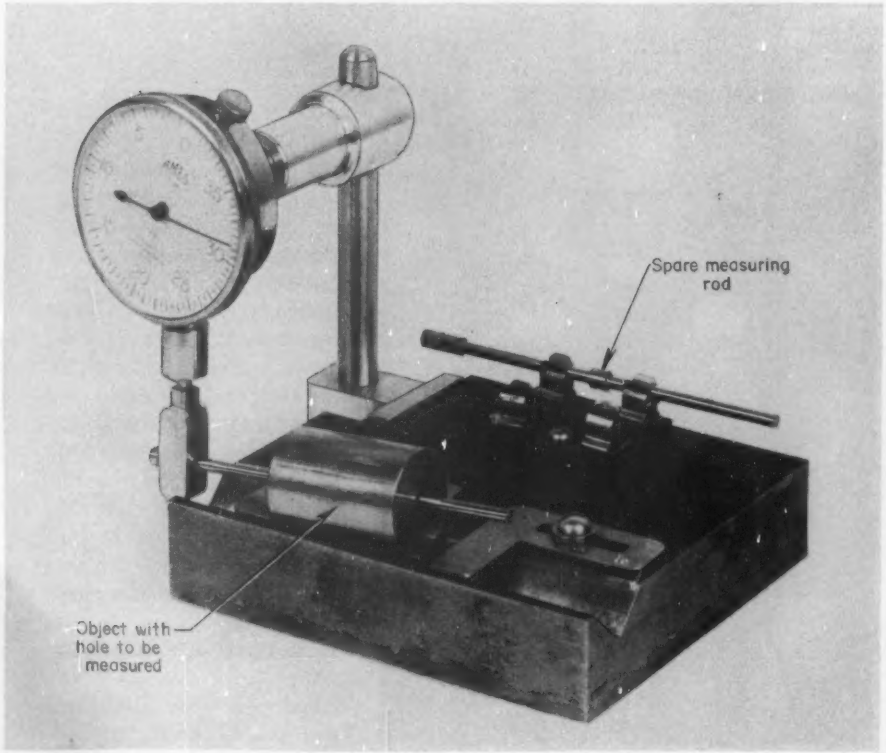
Tandem bellows compensate for ambient pressure and sense pressure to be measured. The compensating bellows is completely sealed, while the sensing bellows is connected to the load. Trunnion at the center furnishes mechanical output for operation of control equipment. Principle employed in fuel-pressure regulator developed by Breeze Corp. Inc., Union, N. J.



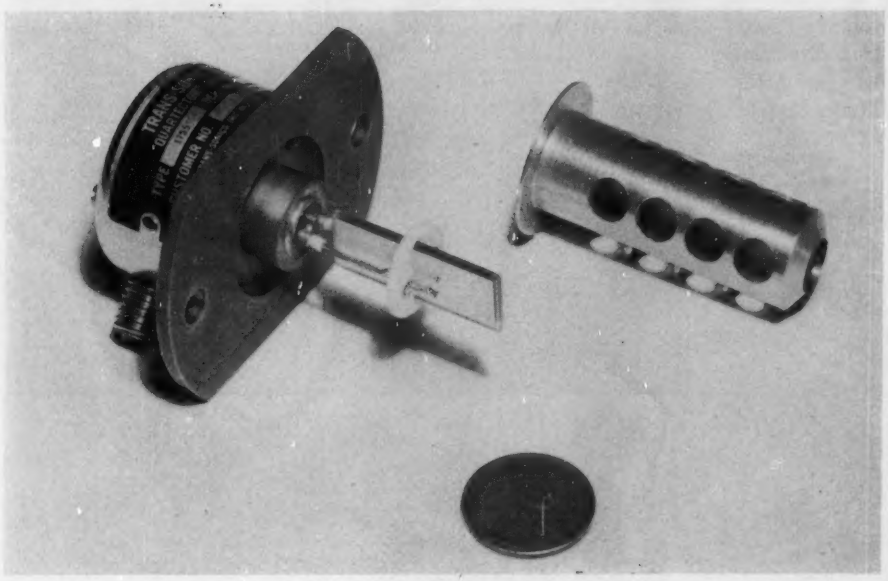
Electronic image matcher determines whether similar appearing objects are identical. Beam from cathode-ray tube is split by a semi-transparent mirror. Each beam portion is then projected through a transparent photograph onto an iconoscope. Difference of the two signals is amplified and displayed on the picture tube. If the photos being compared are identical, no signal is produced on the picture tube. If they are not identical, the differences will be visible as patches that are either brighter or darker than the surrounding area of the screen. Principle employed in scanner developed by NV Philips' Gloeilampenfabrieken, Eindhoven, Holland.



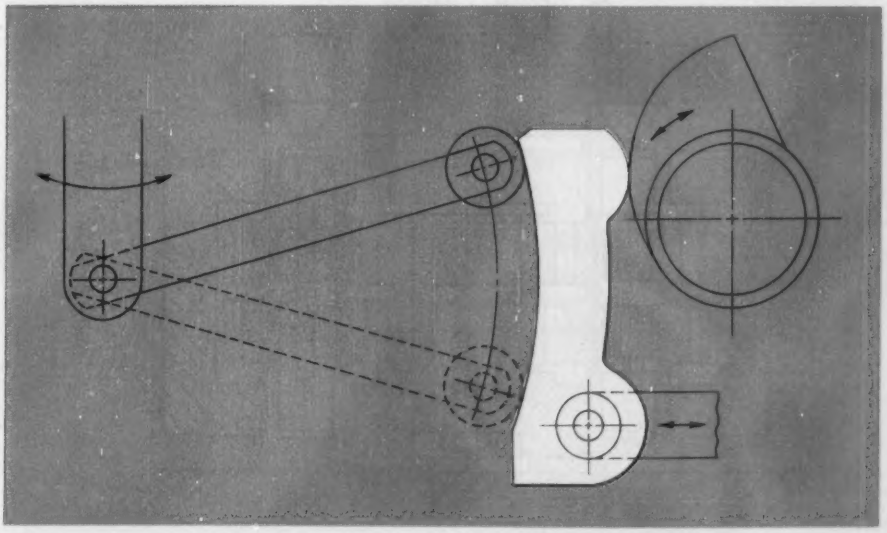
Wobbly cylinder, plus a regular dial indicator, measures small-diameter holes to accuracies of 0.0002 in. The cylinder, of a diameter slightly less than the hole to be measured, is inserted in the hole, and the rod rocked or wobbled by hand. Movement of the rod, a function of the hole size, is measured by the dial indicator. Principle employed in a gage developed by U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.



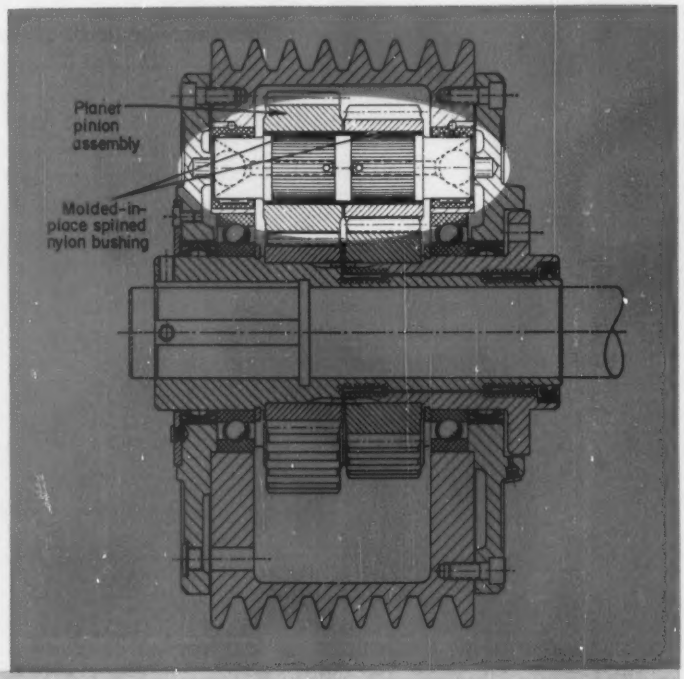
Damped-crystal detector distinguishes between splashing or wetting of sensing element and actual liquid submersion in a liquid detector. A vibrating quartz crystal is damped by the fluid to provide extreme sensitivity to presence or absence of the liquid. Principle employed in a sonic liquid detector developed by Trans-Sonics Inc., Burlington, Mass.

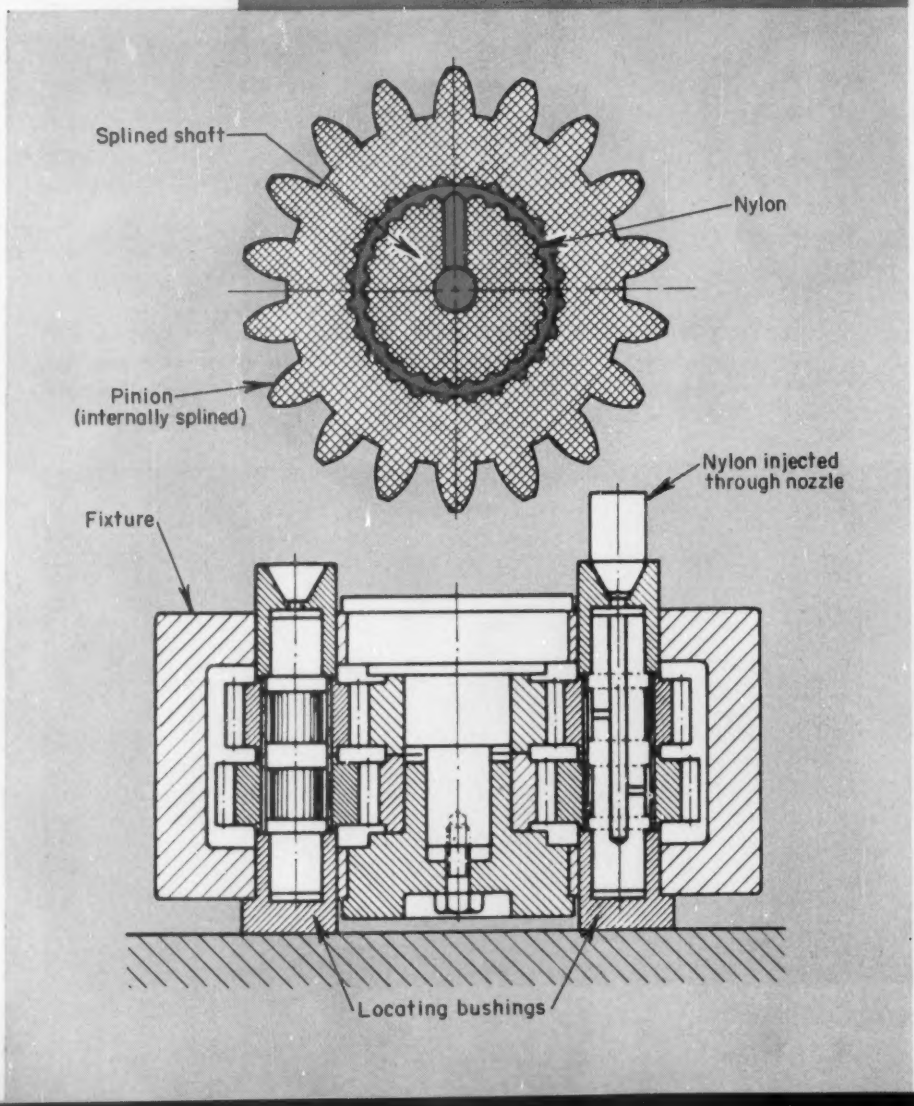


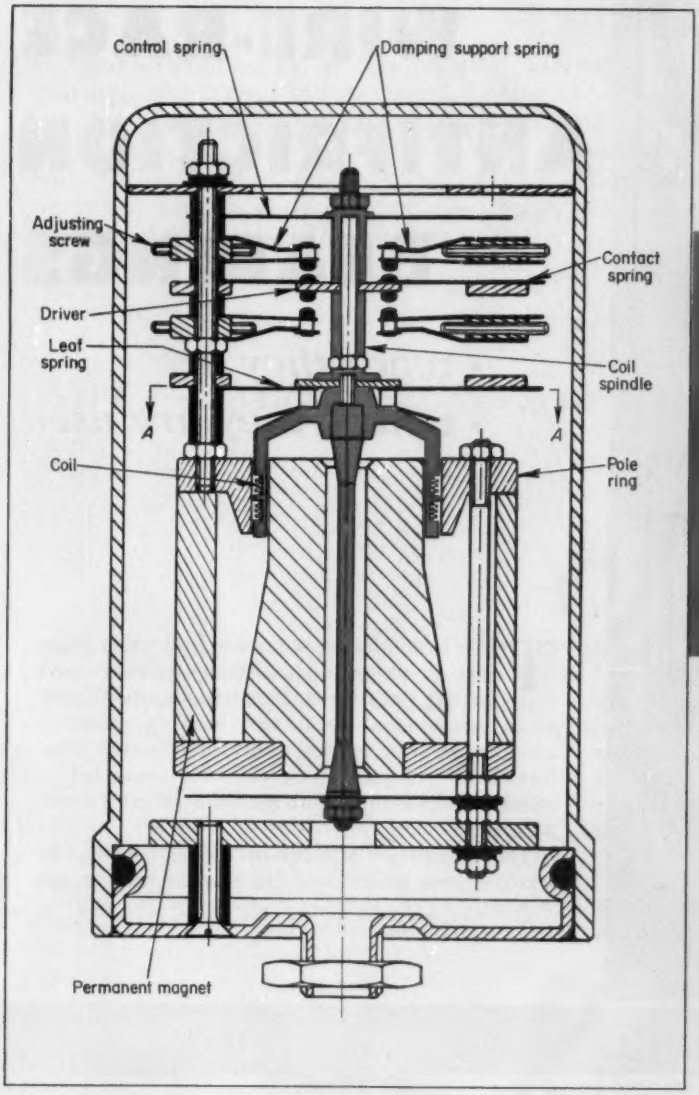
Variable-rate feedback arm in a mechanical servo permits operator to select either of two input signals or an input that is a combination of the two signals. Principle employed in hydraulic hitch servo of tractor developed by Deere and Co., Moline, Ill.

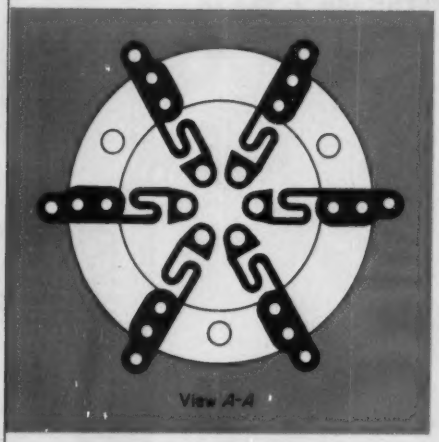


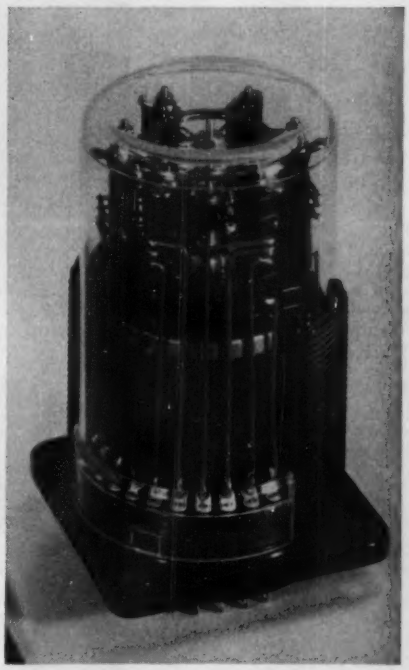
Injected-nylon splining provides overload protection, absorbs shock loads, and permits assembling-in-place production methods for planetary gear sets. In assembly, a fixture is used to locate each individual planet pinion and shaft accurately. Then the two are joined by a molded-in-place nylon bushing. Principle employed in transmission developed by Airborne Accessories Corp., Hillside, N. J.











Moving-coil relay provides polarized response of less than 1 msec. The coil, mounted on flexible leaf springs, moves axially in the field of the annular permanent magnet. The contacts, which can be adjusted for simultaneous or sequential operation, are arranged radially around the coil spindle. Principle in relay developed by Lucifer SA, Carouge-Geneva, Switzerland.

WIRE-RACE ANTIFRICTION BEARINGS

- *what they are*
- *where they are used*

BERNHARD J. BRAUN
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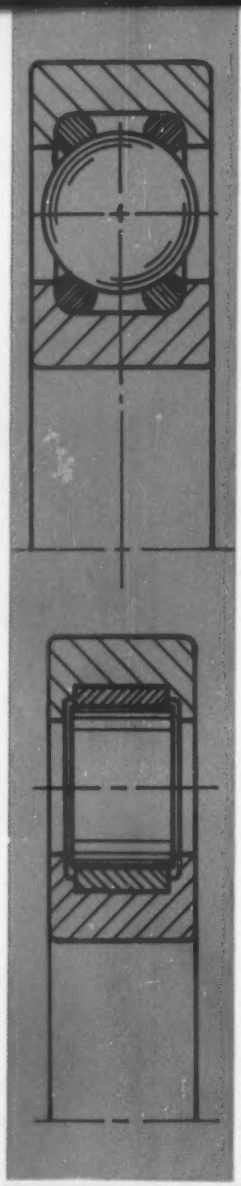


THE basic idea of wire-race antifriction bearings is simple and effective—raceways and bearing rings are separate components. Whereas in conventional antifriction bearings, raceways are integral with bearing rings, in wire-race bearings, balls and rollers run on wires embedded in suitably shaped rings that maintain proper relative positions.

This article, first of a two-part series, supplements a recent news article* and discusses the features and

*See "Wire-Race Bearings"—MACHINE DESIGN, Vol. 32, No. 17, August 18, 1960, p. 30.

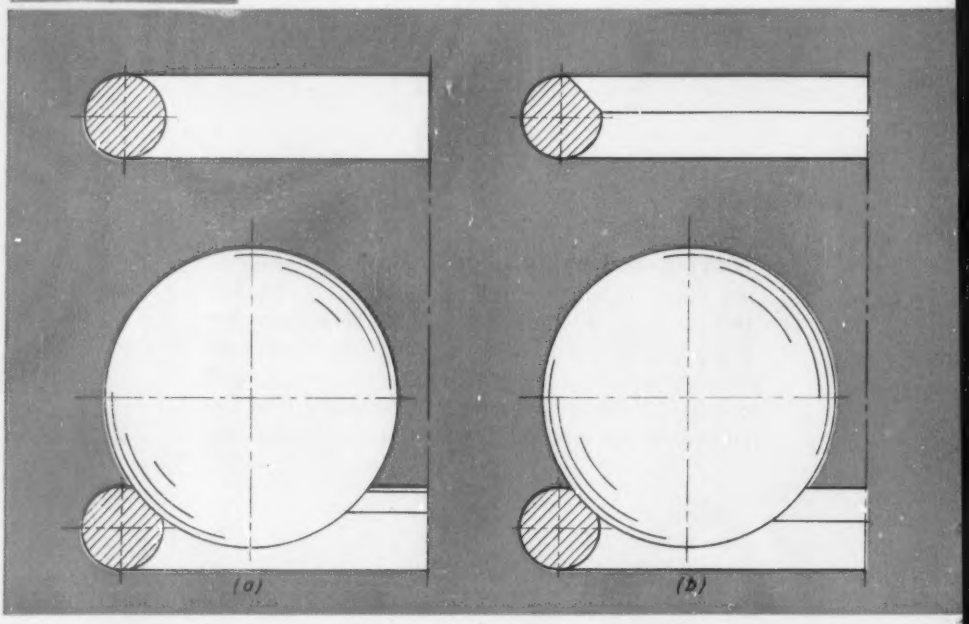


Fig. 1 — Wire raceways for ball bearings are contoured by *a*, rolling-in with a load greater than normal working load; *b*, by pregrinding and rolling-in combined; *c*, by grinding to correct curvature.

Comparative strangers in this country, wire-race antifriction bearings offer several features worth looking at. A single bearing can carry simultaneous radial, thrust, and tilting loads. Bearing rings can be easily preloaded by adjustment of a few bolts. These features qualify wire-race antifriction bearings for many applications requiring precision operation—in sizes ranging from 1 in. to over 20 ft in diameter.

Part 1—Types, Features, and Applications

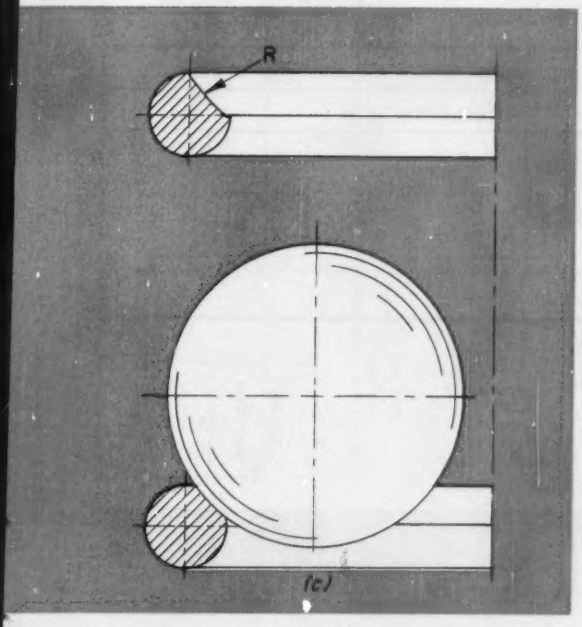
applications of these bearings, made by Eisenwerk Rothe Erde GmbH, Dortmund, Germany. Part two covers load calculations for applying the bearings.

Materials

The unusual design of wire-race bearings enables optimum materials to be selected for each component according to its function in the assembly.

Wires: Raceway wires are formed from high-grade spring steel. Hardness and surface durability of the wires provide high capacity and long bearing life. A gap of about one-third of the wire thickness is left between the ends so that the wires can expand freely in length and make good contact with the enclosing bearing rings. The gap does not impair the load-carrying capacity of the bearing, since the number of rolling elements is large, nor is it noticeable in the performance of the bearing.

Rings: Bearing rings are usually fabricated of tough, unhardened steel, capable of withstanding high shock loads. They do not require heat treatment after finish-machining, since they are not in direct contact with rolling elements of the bearing.



Raceway Contours

To increase capacity and to improve accuracy of bearing assemblies, steel-wire inserts are provided with special running surfaces to carry the rolling elements. These raceway surfaces are produced by rolling-in, by grinding, or by a combination of these operations.

Rolling-In: A few balls or rollers are placed in the bearing. These rolling elements are rotated under a load several times greater than the normal working load of the bearing, causing plastic deformation (cold working) of the wire races and producing highly polished running surfaces. Race curvature matches that of the balls used during the rolling-in process, Fig. 1*a*.

This method can produce raceways up to 0.08 in. wide, depending on wire gage. The same procedure applied to wire-race roller bearings insures uniform loading over the full width of the flat steel wires.

The required pressure of the rolling elements is

obtained by either of two methods: 1. Imposing an external load on the bearing. 2. Preloading the bearing by using its adjusting device.

In the first case, a constant load is continuously applied during the entire rolling-in process. The bearing is rotated under this load until the desired raceway width is attained.

In the second case, the bearing rings are drawn or pressed closer together by tightening the bolts or nuts of the adjusting device. When the bearing is rotated, the pressure gradually decreases because of the permanent deformation of the wires. Adjustment and further rotation of the bearing are repeated until the desired raceway width is obtained.

Pregrinding and Rolling-In: To produce wider raceways for wire-race ball bearings, the wires are first preground (flat), then rolled-in to impart the correct curvature, Fig. 1*b*.

Grinding Only: Recently developed equipment can finish-grind the wires to any desired curvature, Fig. 1*c*, thereby eliminating the need for the rolling-in operation.

Bearing Features

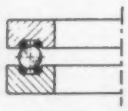
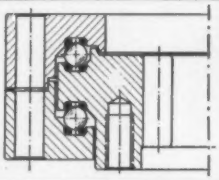
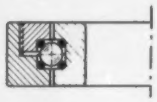
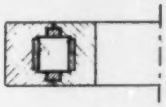
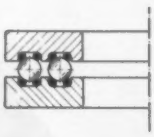
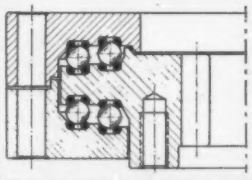
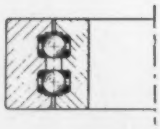
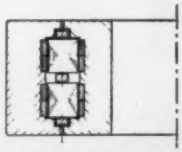
Most wire-race antifriction bearings are designated to carry radial, axial, and tilting loads simultaneously. Because of this, bearing systems comprised of several conventional antifriction bearings often can be replaced by a single wire-race bearing.

Cost: Manufacturing costs of producing wire-race bearings, in many instances, are lower than those of comparable conventional bearings. The main reason is that conventional antifriction-bearing rings must be ground to produce accuracy of shape (concentricity and curvature) and desired surface finish. Neither hardening nor grinding is necessary to produce rings for wire-race antifriction bearings.

Accuracy: Wire-race antifriction bearings — even large-diameter types—can be manufactured to a high degree of accuracy. The wire races, although they are made of hard steel, are flexible and easy to bend or twist, up to a certain degree, because of their small cross section. Under pressure of the rolling elements, the races are pressed tightly against the enclosing unhardened rings, which are ultimately responsible for the accurate running of the bearing.

Bearing assemblies consisting of several rows of rolling elements are largely self-compensating, and rotational errors amount to approximately one-quarter to one-half of the eccentricity in the wire seatings. Inconsistencies in the gage of the race wires do not affect the accuracy of the bearing, since variations in thickness are equalized during the process of rolling-in the wires.

Table 1—Wire-Race Systems, Ball and Roller Bearings

	Ball Bearing			Roller Bearing
	Single Thrust	Double Thrust	Radial	Radial
Main Load	Thrust	Thrust (both directions) and Tilting	Radial	Radial only
Secondary Load	Radial	Radial	Thrust and Tilting	
Single-Row Race System				
Double-Row Race System*				

*Three row and multirow systems are also used.

Mounting: Because the bearing rings remain unhardened, they are readily drilled and tapped for mounting purposes. Or, they may have gear teeth cut in them. This form of construction offers advantages of cost, accuracy, and compactness compared with a separately fitted gear.

Alternate Materials: Although in most cases, bearing rings are made of steel, other materials, such as stainless steel, cast iron, aluminum alloys, or even plastics are sometimes used for the rings of wire-race bearings without considerably altering the load-carrying capacity of the bearing. Actually, bearing capacity depends mainly on the strength properties of the raceway wires. The possibility of using plastic materials or lightweight nonferrous metals becomes important when it is necessary to specify high-capacity antifriction bearings having comparatively light weights and low costs.

Multirow Construction: Several parallel-acting rows of balls or rollers can be used in wire-race bearings, Fig. 2. Wires are rolled-in simultaneously until the load is distributed equally among all rows of balls or rollers. Multirow wire-race antifriction bearings carry high loads and are extremely compact.

Adjustability: Most wire-race antifriction bear-

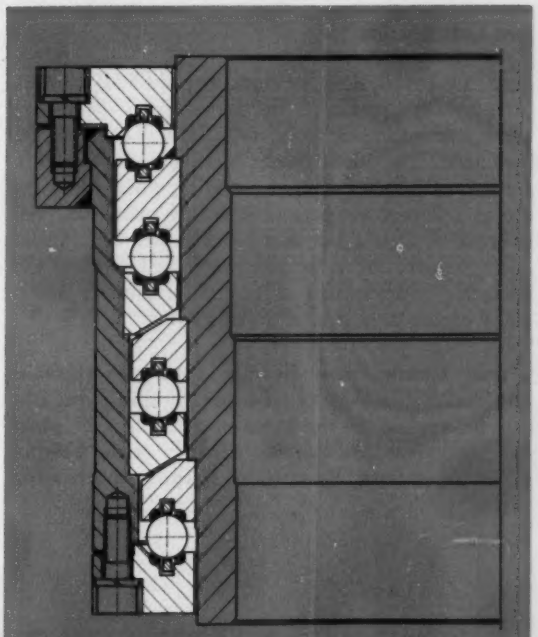
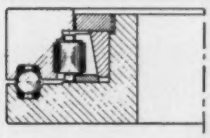
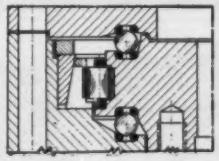
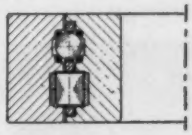
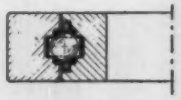
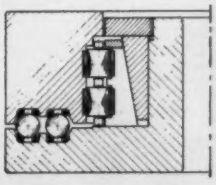
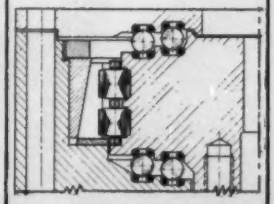
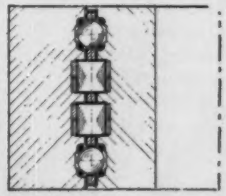
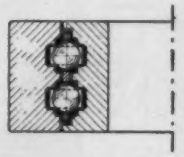


Fig. 2—Compact multirow wire-race antifriction bearings can carry heavy loads and are easily adjusted for preload requirements.

Table 2—Wire-Race Systems, Combined Ball and Roller Bearings

Main Load	Single Thrust, Radial	Double Thrust, Radial, Tilting	Radial	
Secondary Load			Thrust, Tilting	
Single-Row Race System				 See foot note (†)
Double-Row Race System*				

*Three row and multirow systems are also used.
†In single-row ball-and-roller systems, the balls and rollers are installed alternately. Rollers ride on flat wire raceways; balls ride on round wire raceways.

ings can be adjusted to have any desired amount of play or preload. In some cases — for example, in machine tools — bearings have to be preloaded. In other cases, bearings need a large amount of play to prevent jamming when the rings are at different temperatures during operation. An example of such a case is a bearing used for support and guidance of a blast-furnace bell, where the operating temperature of the inner ring is about 300 F higher than that of the outer ring.

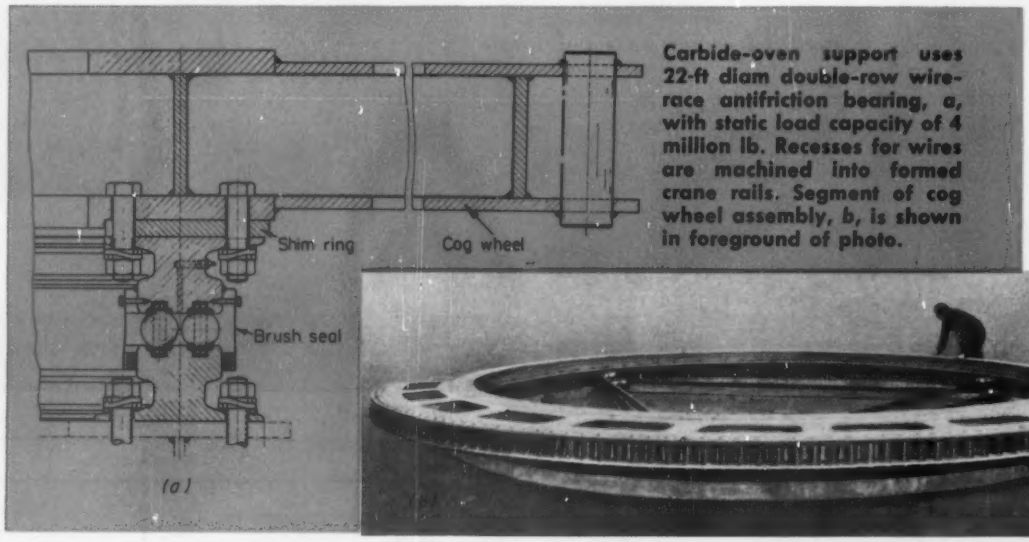
Split Construction: Bearing rings of wire-race antifriction bearings can be of the split type and can be applied in the same manner as split plain bearings. The load-carrying capacity of the bearing is, in some cases, lowered by splitting the bearing rings.

Replacement Wires: Because races are fitted as separate items, independent of bearings rings, replacement of damaged or unserviceable raceway wires is practical. A wire-race antifriction bearing that has reached the end of its lifespan, or that has been damaged through overloading, can be restored at the comparatively low cost of replacement wires.

Bearing Types

Wire-race antifriction bearings are classified in three basic types: 1. Ball bearings, Table 1. 2. Roller bearings, Table 1. 3. Combined ball-and-roller bearings, Table 2.

Although various types of loads are specified in the tables, the proportion and combination of



Carbide-oven support uses 22-ft diam double-row wire-race antifriction bearing, *a*, with static load capacity of 4 million lb. Recesses for wires are machined into formed crane rails. Segment of cog wheel assembly, *b*, is shown in foreground of photo.

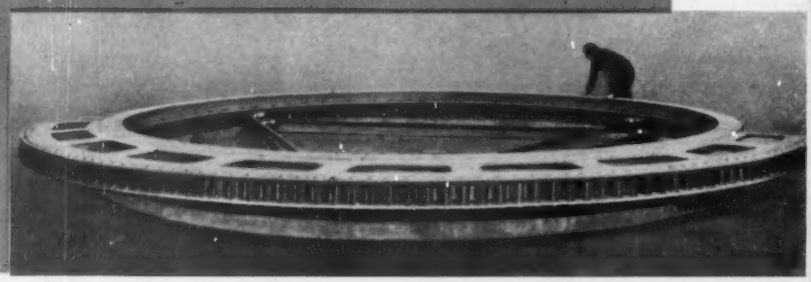
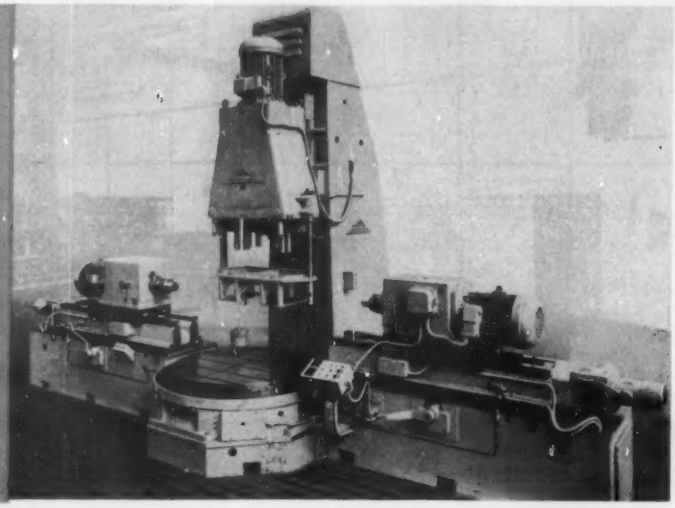


Table of multistation indexing machine is carried on wire-race antifriction bearing. Bearing is rated for simultaneous loads of 33,000 lb radial, 4700 lb axial, and 5000 ft-lb tilt.



loads that the bearings are capable of carrying can be influenced and modified within certain limits by varying the arrangement of wire races in the surrounding rings. Further variations, affecting mainly load-carrying capacities, are achieved by using multirow construction.

Roller-type wire-race antifriction bearings are used to carry radial loads only. All other types can carry a combination of axial, radial, and tilting loads. The ratio of these loads, however, depends on the physical arrangement of wires and rolling elements in the bearing assembly.

Nearly all wire-race antifriction bearings are provided with adjustment devices, Table 3. For combined ball-and-roller bearings, these devices are usually designed so that each pair of bearing rings is independently adjustable.

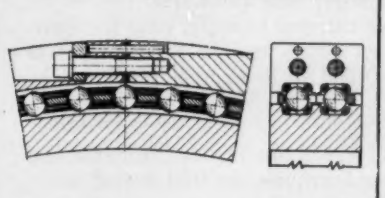
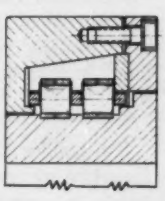
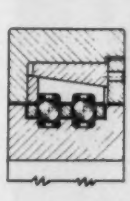
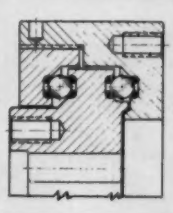
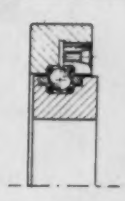
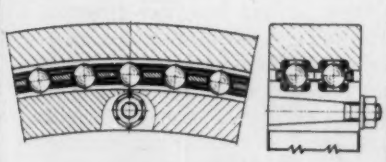
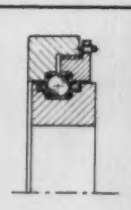
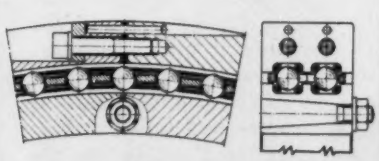
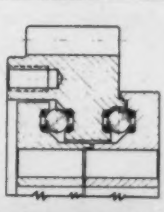
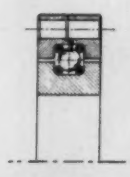
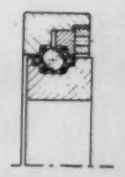
Balls and rollers of wire-race antifriction bearings are usually retained by cages which may be made of any suitable material. In some cases, depending on load-carrying capacity and torque values required, spacers or undersize balls and/or rollers are used to separate the rolling elements.

Wire-race antifriction bearings are lubricated in the same way as conventional antifriction bearings. Labyrinth seals, rubber seals, and plastic seals are often combined with the bearing rings.

Applications

Wire-race bearings are produced in diameters from 1 in. to over 20 ft, and relative rotational speeds of bearing rings as high as 80 to 100 fps are permis-

Table 3—Adjusting Devices for Wire-Race Antifriction Bearings

Split Bearing Ring	Taper Ring		Threaded Ring	
Radial Bearing	Radial Bearing		Double Thrust Bearing	Radial Bearing
Ball and Roller *	Roller	Ball	Ball	Ball
				
	Shim			
	Double Thrust Bearing	Radial Bearing		
	Ball	Ball		
				

*Adjusting devices for radial roller bearings with split bearing rings are the same as those for ball bearings.

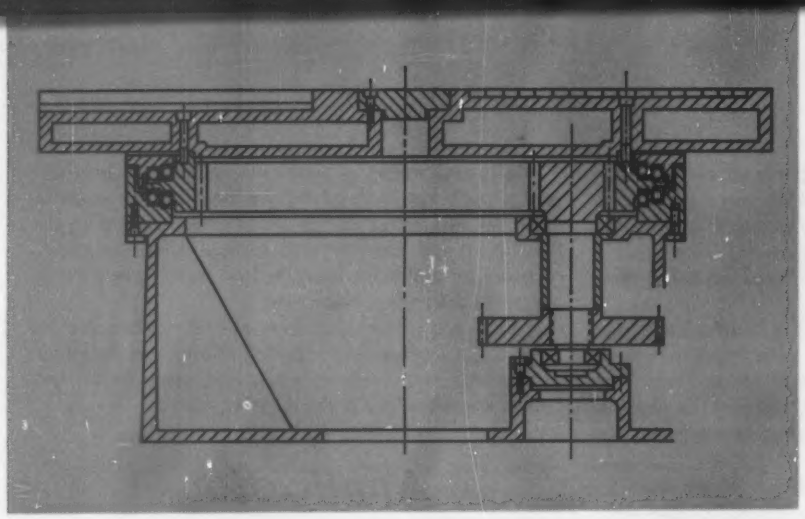
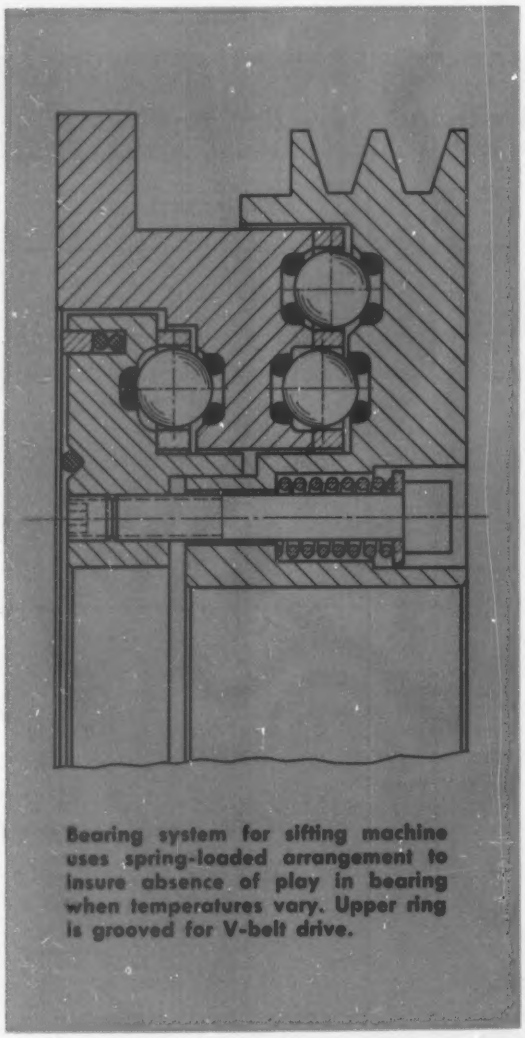


Fig. 3 — Bearing system layout for 8-ft diam turntable shows how center post can be shortened, in effect, to no more than the height of the bearing.

WIRE-RACE BEARINGS



Bearing system for sifting machine uses spring-loaded arrangement to insure absence of play in bearing when temperatures vary. Upper ring is grooved for V-belt drive.

sible. Wire-race antifriction bearings achieve accuracies of the order of 0.0005 in. maximum radial and axial run-out over face (up to about 7-ft bearing diameter). For certain applications these errors can be reduced.

Wire-race antifriction bearings are not intended to replace conventional antifriction bearings. Conventional bearings are available in standard sizes and can be selected from catalogs in which details of load-carrying capacities and corresponding dimensions are given.

Wire-race antifriction bearings, on the other hand, are designed to suit specific applications and frequently offer opportunities to plan the layout of a machine on completely new principles. Special requirements of load-carrying capacity, large diameter, split bearing rings, ability to take several types of load, low weight, and high accuracy often can be met.

Turntables and Faceplates: Latest turntable and faceplate mounting arrangements tend toward shortening the center post and increasing its diameter. These arrangements call for a single large bearing, capable of taking forces applied from any direction, Fig. 3. Large-diameter wire-race antifriction bearings for these applications combine absence of play, high running accuracy, and reasonable cost.

Over-all design of a turntable or faceplate benefits from the layout resulting from the use of a wire-race antifriction bearing support. Assembly is simplified, since a properly preloaded wire-race bearing is assembled to the table and carrier with only a few screws. Considerable time is required to assemble a table having several conventional antifriction bearings and to mount these bearings so that proper preloading, necessary for rigidity, is obtained. In addition, nearly all of the space below the turntable is made available instead of being occupied by the center post and associated bearings, as in a conventional design. In this space, driving elements, tools, or chip trays can be accommodated.

Economic advantages also exist in using wire-race

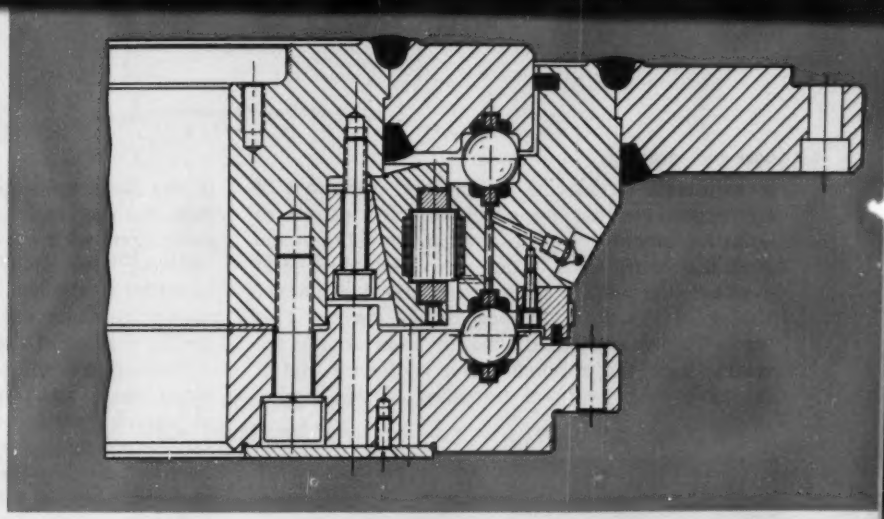


Fig. 4—Wire-race combined ball and roller bearing system for reflecting telescope has high radial-load capacity (rollers) and heavy tilting and thrust-load capacities (balls). Bearing rings for each row are separately adjustable.

antifriction bearings to support turntables and faceplates. Over-all construction is less costly when a wire-race antifriction bearing is applied as compared to using conventional center-post design.

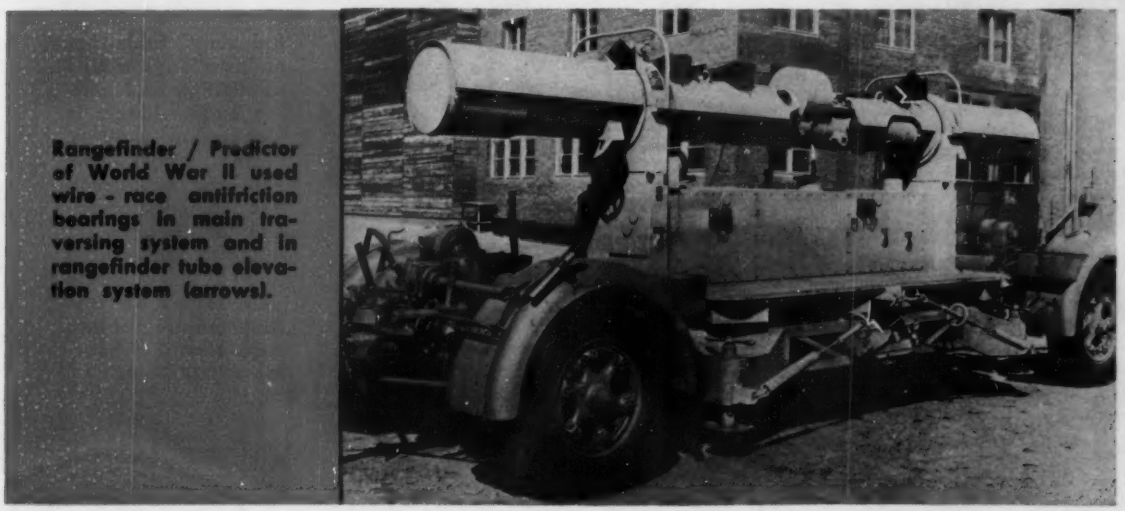
Radio Engineering and Optics: Applications in radio engineering make use of wire-race antifriction bearings to support large radar reflectors and aerial antennas. This equipment, subject to continuous rotary or oscillatory motion at moderate speeds, imposes thrust loads on the bearing because of the weight of the moving system and radial loads and tilting forces because of wind pressures. Bearings for this type of duty must be free from play so that the unit turns smoothly and without vibration under heavy wind pressure.

Wire-race antifriction bearings are used in optical and astronomical equipment such as reflecting telescopes, Fig. 4, where the need for zero play and minimal limits of radial and angular runout is of utmost importance in the system. Even in the large-diameter versions, these requirements are met without difficulty with wire-race antifriction bearings.

Armaments: During World War II, tens of thousands of wire-race ball bearings were used in equipment such as bomb-release gear, combined height/rangefinder/ predictor units, fire-control units, gun carriages, submarine periscopes, co-ordinate converters, and naval gun turrets.

The inherent properties of the wire-race antifriction bearing make it especially suitable for armaments applications. Most military equipment must be compact and light in weight. The use of bearing rings of lightmetals or plastics or even omission of bearing rings (by mounting raceway wires directly into the surrounding parts), can save space and weight. The importance of this factor is obvious, especially in rockets and missiles, where weight often determines the value of the entire design.

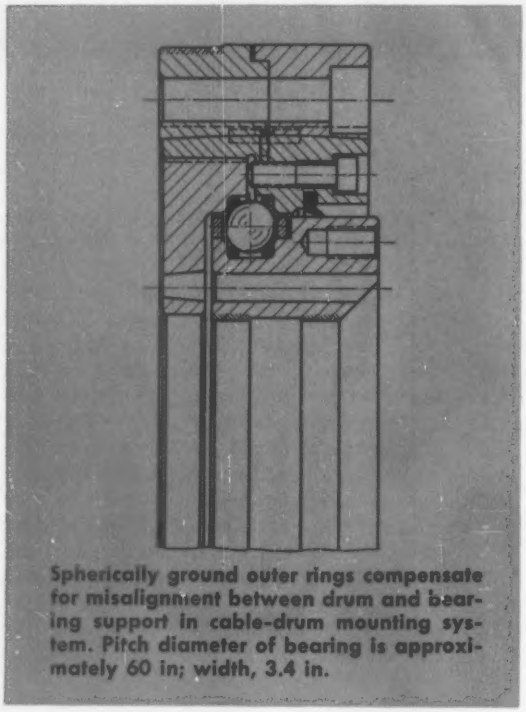
A point of special interest in armament design is the fact that wire-race antifriction bearings are readi-



Rangefinder / Predictor of World War II used wire - race antifriction bearings in main traversing system and in rangefinder tube elevation system (arrows).

ly adjustable for play or for preload. Raceways of antifriction bearings on which armored turrets of tanks are mounted tend to develop brinelling at the pitch line of the balls. These marks introduce jerkiness into the rotation of the turret and thus hamper aiming of the gun mounted in the turret. This type of indentation results mainly from driving the vehicle with the armored turret stationary and is caused by the continual brinelling of the bearing in the static condition. The condition can be lessened to a marked degree by preloading the bearing—easily done with a wire-race antifriction bearing. In addition, with wire-race ball bearings, the process of rolling-in the race wires produces line contact between the balls and the races. This reduces the specific loading of the raceways by the balls.

Furthermore, the ability to change raceway wires when needed has proved to be a very useful feature of wire-race antifriction bearings as applied to military equipment. Wire-race bearings whose races have become damaged can be restored by fitting new raceway wires—a process which is rapidly done at little cost.



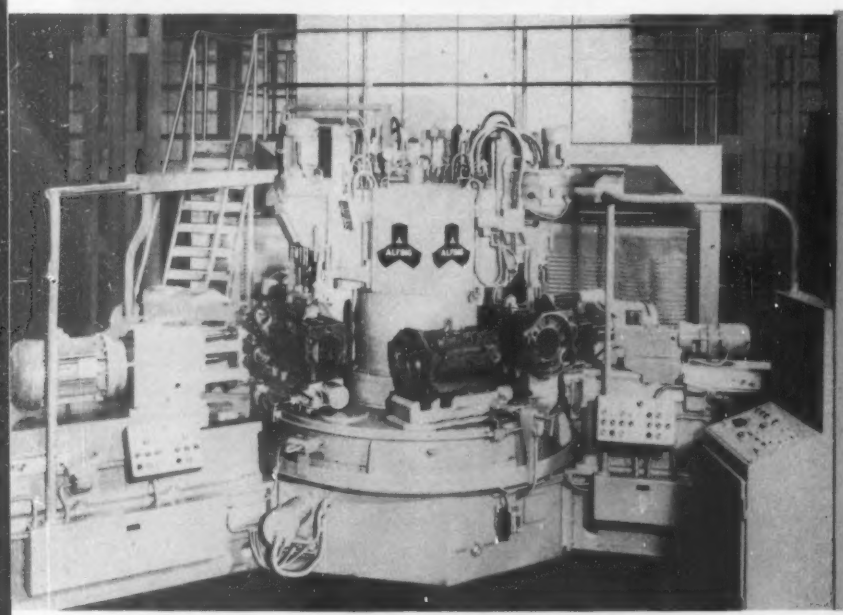
Spherically ground outer rings compensate for misalignment between drum and bearing support in cable-drum mounting system. Pitch diameter of bearing is approximately 60 in; width, 3.4 in.

Other Applications: Wire-race antifriction bearings, in a great range of types, are used in rotary furnaces and kilns, revolving drums, mixer tanks, revolving hoppers, rotary screens, feeder worms, and similar equipment. These bearings often operate at 500 F and above. Effective sealing arrangements built into the bearings exclude dirt and moisture from the races.

The food industry uses wire-race antifriction bearings for turntables, kneading drums, and grinding mills of all kinds. Bearings exposed to corrosive media are made of suitable corrosion-resistant materials.

Further applications include machines for cable winding, machines for bark removal in the woodworking industry, thread-cutting machines, jolt-squeeze machines, charging bells on blast furnaces, and x-ray equipment.

The next article, concluding the series, presents calculations for various types of loads on wire-race antifriction bearings.



Indexing table of multistation machine for drilling and milling engine blocks is mounted on a 40-in. diam single-row wire-race antifriction bearing. Load capacity of bearing is 3000 lb radial and 3000 lb thrust, acting simultaneously. Maximum radial and axial runout of bearing is 0.0004 in.

When experimental curves serve as basic and recurring criteria in design, they generally are more useful and convenient if converted to equations.

An easy way to convert data to empirical equations is to plot them as straight lines—if you can find the particular x and y scales that will straighten the curves.

Here are methods for converting . . .

Curves to Straight Lines

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PLOTTING a graph of experimental results gives a helpful picture of the relationship of two or more variables. Often such a record is adequate for the job at hand.

But, expressing the same information as an empirical equation offers advantages, or may be an essential step toward other objectives. For example, equations can

1. Present extensive data in compact form.
2. Provide for easy and accurate interpolation.
3. Condition data for transformation to easier-to-use graphical forms, such as nomograms.

Writing the equation is easy if nature dictates straight lines on linear graph paper. When curves result, the obvious trick is to try plotting the points on nonlinear scales to see if the curves will straighten. If they do, the rest is simple.

Picking the right kind of graph paper on the first choice is often a matter of chance. However, odds are improved if the experimental curves can be compared with charts of various mathematical functions. Such charts are presented in this article. How to use them to find the right scales, and to

Table 1—Three-Variable Functions and Linearizing Co-ordinates

	Plot of		(a) z	(b) $\log z$	(c) $\text{llog } z$
1	y	x	$y = B + mx + nz$	$y = B + mx + n \log z$	$y = B + mx + n \text{llog} z$
2	$\log y$	x	$y = Bd^{mx+nz}$ $\log y = \log B + m(\log d)x + n(\log d)z$	$y = Bd^{mx}z^n$ $\log y = \log B + m(\log d)x + n(\log z)$	$y = Bd^{mx}(\log z)^n$ $\log y = \log B + m(\log d)x + n(\text{llog } z)$
3	$\log y$	$\log x$	$y = Bx^m d^{nz}$ $\log y = \log B + m(\log x) + n(\log d)z$	$y = Bx^m z^n$ $\log y = \log B + m(\log x) + n(\log z)$	$y = Bx^m(\log z)^n$ $\log y = \log B + m(\log x) + n(\text{llog } z)$
4	$\text{llog } y$	x	$y = B^{d^{mx+nz}}$ $\text{llog } y = \text{llog } B + m(\log d)x + n(\log d)z$	$y = B^{d^{mx}z^n}$ $\text{llog } y = \text{llog } B + m(\log d)x + n(\log z)$	$y = B^{d^{mx}(\log z)^n}$ $\text{llog } y = \text{llog } B + m(\log d)x + n(\text{llog } z)$
5	$\text{llog } y$	$\log x$	$y = B^{x^m d^{nz}}$ $\text{llog } y = \text{llog } B + m(\log x) + n(\log d)z$	$y = B^{x^m z^n}$ $\text{llog } y = \text{llog } B + m(\log x) + n(\log z)$	$y = B^{x^m(\log z)^n}$ $\text{llog } y = \text{llog } B + m(\log x) + n(\text{llog } z)$
6	$\text{llog } y$	$\text{llog } x$	$y = B^{(\log x)^m d^{nz}}$ $\text{llog } y = \text{llog } B + m(\text{llog } x) + n(\log d)z$	$y = B^{(\log x)^m z^n}$ $\text{llog } y = \text{llog } B + m(\text{llog } x) + n(\log z)$	$y = B^{(\log x)^m(\log z)^n}$ $\text{llog } y = \text{llog } B + m(\text{llog } x) + n(\text{llog } z)$
7	y	$\log x$	$y = B + m(\log x) + nz$	$y = B + m(\log x) + n(\log z)$	$y = B + m(\log x) + n(\text{llog } z)$
8	y	$\text{llog } x$	$y = B + m(\text{llog } x) + nz$	$y = B + m(\text{llog } x) + n(\log z)$	$y = B + m(\text{llog } x) + n(\text{llog } z)$
9	$\log y$	$\text{llog } x$	$y = B(\log x)^m d^{nz}$ $\log y = \log B + m(\text{llog } x) + n(\log d)z$	$y = B(\log x)^m z^n$ $\log y = \log B + m(\text{llog } x) + n(\log z)$	$y = B(\log x)^m(\log z)^n$ $\log y = \log B + m(\text{llog } x) + n(\text{llog } z)$

evaluate equation constants, are also outlined and illustrated.

Two-Variable Charts: There are many ways in which experimental data may be plotted. In Cartesian co-ordinates, everyone is familiar with ordinate and abscissa scales that are linear, logarithmic and log-logarithmic (abbreviated as llog). Six basic combinations of functions can be formed from these three scales along two co-ordinates, Table 1 and Fig. 1 to 6. Both scales of Fig. 1 are linear. Fig. 2 has a vertical logarithmic scale and a linear horizontal scale, and so on.

The functions of y defined by Equations 1 to 6, Table 2, are plotted as a set of master curves or chart, Fig. 1 to 6. Each curve is identified by an equation number.

The constants of these six functions were chosen so that all the curves pass through the point (100, 1000), $x = 100$, $y = 1000$, and through or near the origin, as point (0, 5) for curve 1. The general form of Equation 1 is:

$$y = B + mx \tag{7}$$

which is a linear function because the variables appear only in the first degree, multiplied by constants, and combined only by addition and subtraction.

Equation 1 appears as a straight line in Fig. 1 for which both scales are linear. It appears as a curve in Fig. 2 to 6 where one scale, or both, is nonlinear.

A general form of Equation 2 is

$$y = B d^{mx} \tag{8}$$

which is linearized by forming logarithms of both sides. This operation gives

$$\log y = \log B + mx \log d \tag{9}$$

which may be easily recognized as a linear function in variables x and $Y = \log y$ when rewritten in the form

$$Y = B_{10} + m_{10}x \tag{10}$$

where $B_{10} = \log B$ and $m_{10} = m \log d$.

Equation 2 appears as a straight line in Fig. 2 where the vertical scale is logarithmic and the horizontal scale is linear. It appears as a curve in Fig. 1 and in Fig. 3 to 6 where one scale, or both, is not logarithmic. Likewise, Equation 3 is a straight line in Fig. 3, and so on.

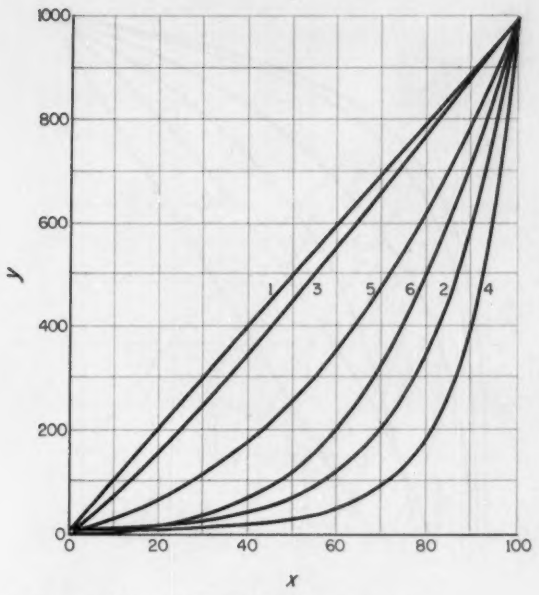

Fig. 1—Linear plots of Equations 1 to 6.

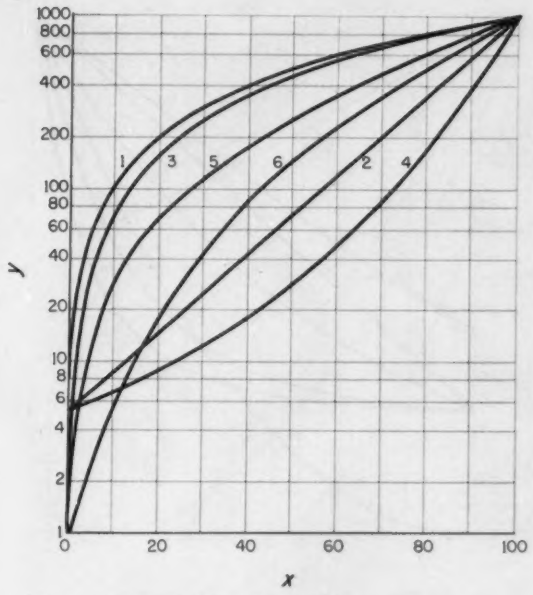

Fig. 2—Log-linear plots of Equations 1 to 6.

To Use the Charts: Assume a set of experimental data relating two variables are plotted on ordinary cross-section paper to the same scales as Fig. 1 or proportional thereto. And suppose the plot is a curve that looks like curve 4. The next step is to plot the data to llog-linear scales. If the plotted points do lie upon a straight line, they define a linear function of the type,

$$Y = Y_0 + mx \log d \qquad (11)$$

where Y = llog y and Y_0 = llog B. The intercept Y_0 and the slope m log d can be determined by measurements of the straight line, Fig. 4. These values then are used to find constants B, m, and d for substitution into an equation of the type $y = B^p$ where $p = d^{mx}$.

If the plotted points on the llog-linear scales do not lie upon a line, plots to other combinations of scales can be made. Curves 5, 6, and 2 all look somewhat like 4, Fig. 1. It is entirely possible that none of the combinations of scales will linearize a given set of experimental data. Frequently, it is necessary to add or subtract a constant from the ordinate or abscissa values to achieve linearization. Sometimes constants need to be applied to both.

Furthermore, the charts bring out the significant fact that some of the functions are relatively insensitive to nonlinearity. For instance, the charts of Fig. 1 to 4 show greater differences between the curves than do the charts of Fig. 5 and 6. This means that greater care may be necessary in plotting to llog-log or llog-llog co-ordinates if true linearization is to be realized.

Moreover, other charts can be constructed that may be better suited than Fig. 1 to 6 for linearizing data. For example, the constants could be chosen so that all the curves of Fig. 1 would slope downward to the right. Also, it is possible to select constants such that curves 2 to 6 would all lie above curve 1 instead of below it.

Table 2—Functions for Curves in Fig. 1 to 6

Equation	No.
$y = 5 + 9.95x$	(1)
$y = 5(2)^{0.0764x}$	(2)
$y = 5x^{1.15}$	(3)
$y = 5^{2^{0.0211x}}$	(4)
$y = 5^{x^{0.316}}$	(5)
$y = 5^{(\log x)^{2.10}}$	(6)

Three-Variable Functions: Let a third variable z be added so that the equations become functions of x, y, and z. However, when a research is carried on with variables in dimensionless form, a

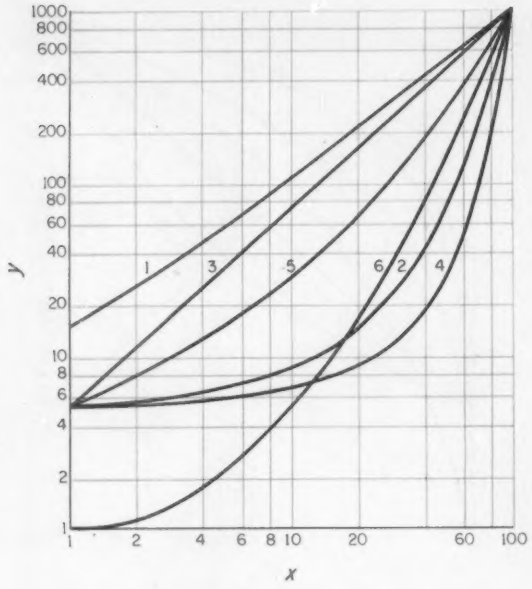

Fig. 3—Log-log plots of Equations 1 to 6.

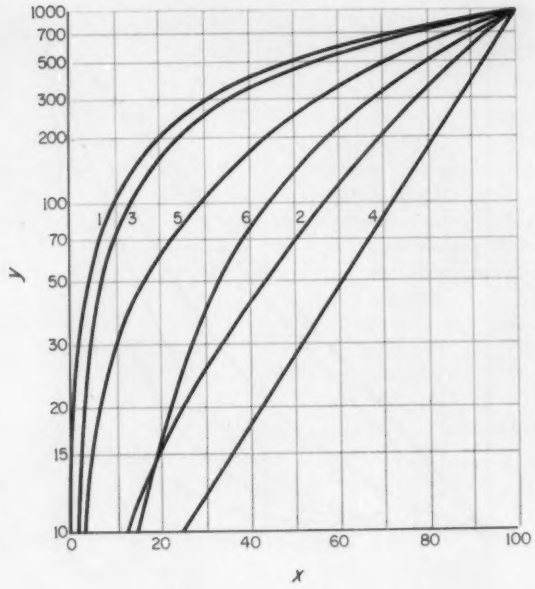

Fig. 4—Llog-linear plots of Equations 1 to 6.

number of individual variables can be analyzed as a dimensionless group.[1] Thus, the x, y, z variables could each correspond to a dimensionless group.

What is the appearance of the various types of three-variable mathematical functions when plotted on different types of graph paper? Fig. 7 illustrates linear plots of a certain function for selected values of variable z. Fig. 8 illustrates the same function when linearized by llog-linear scales. The general equation as a type of function is also indicated. Similarly, Fig. 9 and 10 illustrate linear and linearized plots of another specific function as well as the corresponding general equation with undetermined constants.

The addition of the variable z at least triples the number of combinations of co-ordinate scales that can be formed. If alternate roles of variables x and y are admitted, 27 arrangements of three-variable equations may be plotted as straight lines on suitable co-ordinate scales. Table 1 lists these 27 arrangements.

The nine at the bottom, identified by row numbers 7, 8, and 9, are similar to those identified by row numbers 2, 4, and 5, but with the roles of x and y interchanged. They provide completeness and convenience. By columns a, b, and c, the functions are subdivided according to the nature of the z scale.

Table 3—Scale Modulus Definition

Type of Plot	Length of Scale Modulus λ
Linear	0 to 1
Log	1 to 10
Llog	10 to 10^{10}

[1]References are tabulated at end of article.

The functions are stated as equations in the usual algebraic form as well as in the logarithmic form where necessary for linearization of the particular function.

Any equation in Table 1 can be designated by a letter-number symbol. Thus, designation $4b$ means row 4, column b; that is, the function should plot as a straight line if plotted on llog-linear co-ordinates with z as a logarithmic co-ordinate. Accordingly, Fig. 7 illustrates the influence of z on the equation in its algebraic form, and Fig. 8 illustrates the application of the z co-ordinate in a llog-linear graph.

Analogously, Fig. 9 and 10 apply to function designation $5b$. The heavy dashed lines which proceed upward to the right at a steep angle, Fig. 10, are intended to show a procedure for laying off the overlapping log z scale. A detailed discussion of the procedure is given in Reference 2.

Evaluation of Constants: The constants that appear often in the functions are B, d, m, and n and sometimes log d. The evaluation of them involves the definition of the scale modulus, the mathematical slope, and the geometric or measured slope. The scale modulus is the measured length of one cycle or one repeated sequence of a given variable as shown in Table 3.

The scale moduli for the three variables are designated by λ_x, λ_y, and λ_z. The projection in the y direction of one cycle in the z direction is designated by λ_{zy}. These definitions are presented graphically in Fig. 8 and 10. Constant k is also defined in Fig. 8 and 10, being the geometric or measured slope. It is the actual slope of the z lines.

Mathematical slopes m and n depend mainly upon the geometric or measured slope, k, and the scale moduli, λ_x, λ_y, and λ_{zy}. Occasionally, log d is also

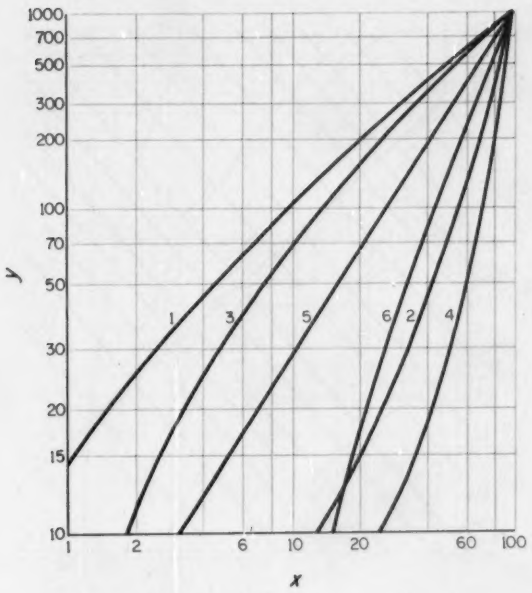

Fig. 5—Llog-log plots of Equations 1 to 6.

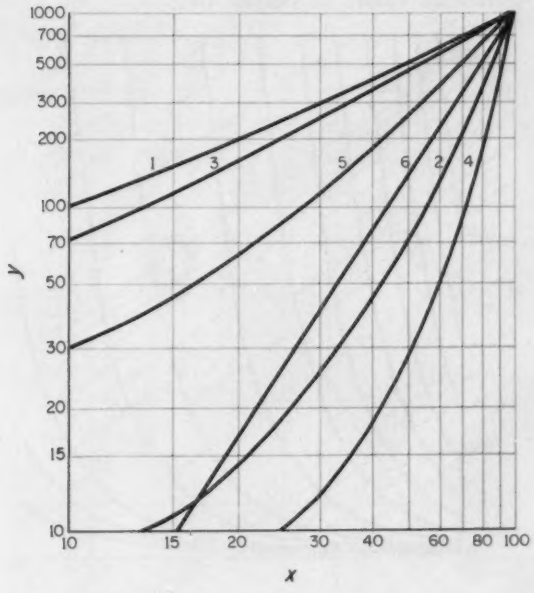

Fig. 6—Llog-llog plots of Equations 1 to 6.

necessary to determine m and n. Equations for calculating values of m and n are given in Table 4. Logarithms are to base 10.

For example, consider the log-log plot of the function defined by $3b$, Tables 1 and 4. The mathematical slope of the z variable lines is defined by m. If the function is of the type designated by $4b$, then log d modifies the slope, Table 4. Reference 2 discusses more completely the manner in which the moduli influence m and n.

Linearized Series Functions: Other techniques are available for linearizing series functions such as those for sine and cosine functions. A special co-ordinate

Available Graph Papers

Only four of the nine ordinate and abscissa scale arrangements presented in Table 1 are known to be commercially available. These are types 1, 2, 3 and 7. The remaining five types involve llog scales. On the other hand, many types of graph paper are commercially available which may be useful in the analysis of experimental data.

The available papers include in addition to the foregoing: Polar, reciprocal or hyperbolic, triangular, arc hyperbolic sine, arc tangent, probability-logarithmic, and probability-linear.

Co-ordinates by Construction

As an example of the method of construction of desired co-ordinate systems which are not available, consider the llog scale. The llog cycle extends from 10 to 10^{10} and the scale may be constructed from a log scale as follows: On the log scale 2 corresponds to 10^2, 5 corresponds to 10^5, but the subdivisions between the whole numbers of the log scale can not be used in the same way.

Consider 2.5 on the log scale; this corresponds to $10^{2.5}$ and hence, it probably is not an even or whole number. There is a striking feature of the conversion, however. The subdivision from 10 to 9, 9 to 8, 8 to 7, . . . 3 to 2, and 2 to 1 is exactly the same in each case. Hence the calculations for one region only are needed.

These calculations can be made either from a table or from a slide rule depending on the desired accuracy. If a llog slide rule is used, the llog scale values corresponding to given log scale values can be determined directly.

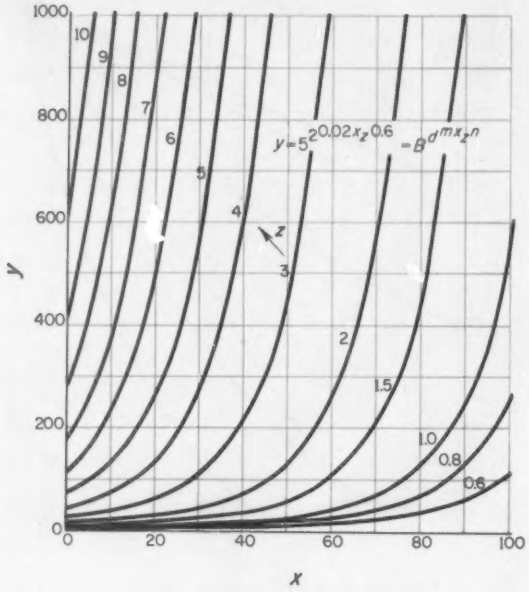

Fig. 7—Linear plot of a function of type 4*b* for selected values of variable *z*.

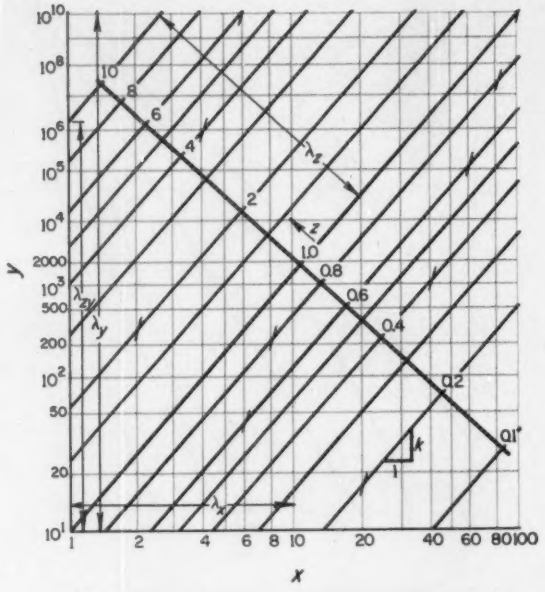

Fig. 8—Llog-linear plot of the function of Fig. 7 with diagonal logarithmic scale for *z*. Function type, 4*b*.

paper, called linear sine paper,[3] yields a true straight line for sine functions.

In Fig. 11, a log-log co-ordinate system has been used which extends from 1 to 90 deg on the abscissa and from 0.01 to 1.0 on the ordinate. That is, the right-hand side of the second cycle is not included on the abscissa. The series expansion for the cosine is

$$\cos\theta = 1 - \frac{\theta^2}{2} + \frac{\theta^4}{24} - \frac{\theta^6}{720} + \ldots \qquad (12)$$

or

$$1 - \cos\theta \approx 0.50\,\theta^2 - 0.04\,\theta^4 \qquad (13)$$

For $\theta = 1$ radian the two-term approximation is in

Table 4—Evaluation of Exponents

Plot of			(*a*) z	(*b*) log z	(*c*) llog z
1.	y	x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$
2.	log y	x	$m = k\lambda_x/\lambda_y \log d$ $n = \lambda_{zy}/\lambda_y \log d$	$m = k\lambda_x/\lambda_y \log d$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y \log d$ $n = \lambda_{zy}/\lambda_y$
3.	log y	log x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y \log d$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$
4.	llog y	x	$m = k\lambda_x/\lambda_y \log d$ $n = \lambda_{zy}/\lambda_y \log d$	$m = k\lambda_x/\lambda_y \log d$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y \log d$ $n = \lambda_{zy}/\lambda_y$
5.	llog y	log x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y \log d$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$
6.	llog y	llog x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y \log d$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$
7.	y	log x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$
8.	y	llog x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$
9.	log y	llog x	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y \log d$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$	$m = k\lambda_x/\lambda_y$ $n = \lambda_{zy}/\lambda_y$

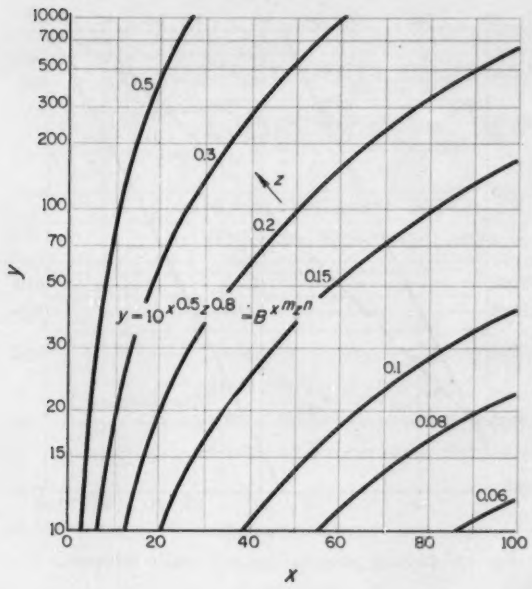

Fig. 9—Llog-linear plot of a function of type 5*b* for selected values of variable *z*.

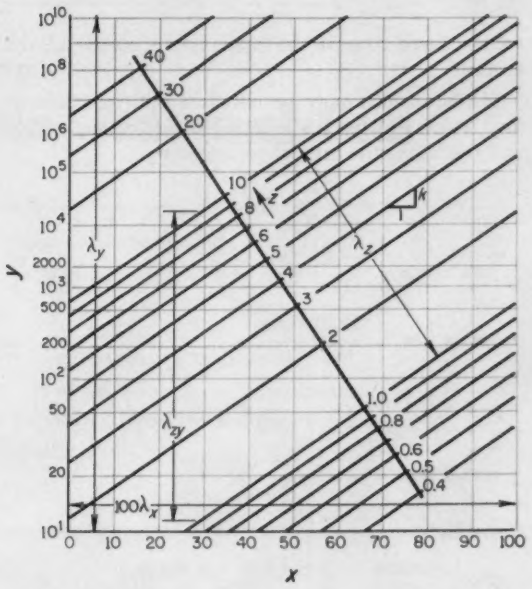

Fig. 10—Llog-log plot of the function of Fig. 9 with diagonal logarithmic scale for *z*. Function type, 5*b*.

error by only 0.4 per cent. For $\theta = 0.5003$ radian, the single term, $0.5\ \theta^3$, is in error by only 0.24 per cent. Thus it is clear that the true values, which are actually plotted in Fig. 11, would deviate only slightly from a line with a geometric slope of plus 2 since $\lambda_x = \lambda_y$ in this instance.

The values for sin ϕ result from writing sin ϕ = cos(90 − θ), hence the sine terms are read from the same ordinates with the abscissa scale reading from right to left at the top of the graph. The solid diagonal line on the left-hand half of the graph is a continuation of the solid line on the right-hand side and extends the range of θ down to 1 deg. Note the very high order of accuracy achieved for the sine and cosine in the range where θ approaches 1 deg and ϕ approaches 89 deg.

The dashed line in Fig. 11 has a slope of 1 and represents the equation $\theta_{rad} = (\pi/180)\,\theta_{deg}$. It also represents sin θ vs θ and cos ϕ vs ϕ. The series expansion in this case is approximately sin $\theta \approx \theta - 0.16\ \theta^3$. The curves are seen to be essentially identical until $\theta = 20$ deg at which point the true sine

EXAMPLES

Fluid Mechanics: The equation for the average friction coefficient of the turbulent boundary layer used in fluid mechanics[1] may be expressed by

$$C_f = \frac{0.455}{(\log_{10} R_x)^{2.58}}$$

where R_x is Reynolds number. This is a type 5*b* function with $z = 1$ and can be rewritten as

$$\text{llog } R_x = \text{llog } 5.46 - 0.3876 \log C_f$$

or as $R_x = 5.46^p$ where $p = C_f^{-0.3876}$.

For experimental work, therefore, a llog-log plot of R_x as ordinate and C_f as abscissa permits ready verification of test data in this phase of fluid mechanics.

Electrical Charge: The decay and charge of voltage in a resistance-capacitance circuit is illustrative of a type 2*b* function with $z = 1$. The equation defining discharge is

$$\frac{v}{V_0} = e^{-t/RC}$$

while the equation defining charge is

$$1 - \frac{v}{V_0} = e^{-t/RC}$$

where *RC* is the time constant of the circuit.

A log-linear plot of v/V_0 as ordinate and t/RC as abscissa leads directly to a solution for the discharge condition. A similar plot of $(1 - v/V_0)$ as ordinate and t/RC as abscissa gives the charge relationship.

For the latter, Fig. 11 can be altered so that the voltages of charge are read at once. The ordinates are relabeled so that 1 corresponds to 0, 0.1 to 0.9, 0.01 to 0.99, and so on.

values curve toward the upper right corner of the graph.

Similar results may be obtained with the following series expansions,[4] again using log-log paper and relabeling the axes where necessary:

$$e^x = 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \ldots \qquad x^2 < \infty$$

$$\tan x = x + \frac{x^3}{3} + \frac{x^5}{7.5} + \ldots \qquad x^2 < \frac{\pi^2}{4}$$

$$\sinh x = x + \frac{x^3}{6} + \frac{x^5}{120} + \ldots \qquad x^2 < \infty$$

$$\cosh x = 1 + \frac{x^2}{2} + \frac{x^4}{24} + \ldots \qquad x^2 < \infty$$

$$\tanh x = x - \frac{x^3}{3} + \frac{x^5}{7.5} - \ldots \qquad x^2 < \frac{\pi^2}{4}$$

Consider

$$[(\cosh x) - 1] \approx 0.5\,x^2 + 0.042\,x^4 + \ldots$$

In this case, values of $(\cosh x) - 1$ are plotted on the log-log paper and the ordinate for a point such as 0.1 is assigned the number 1 so that values of cosh x are read directly. As before, the slope is approximately 2. Clearly e^x plots as a true straight line on log-linear or linear-log paper. It is listed above only to show the versatility of log-log plotting.

The charge equation of an example is an exponential and can be treated in the manner of Equation 13 and Fig. 11. If the ordinates are relabeled with 1.0 at 0.0, 0.1 at 0.9, and 0.01 at 0.99, the voltages for charge are read at once. Electrical engineers now plot *RC* circuit data in this way for rapid verification.

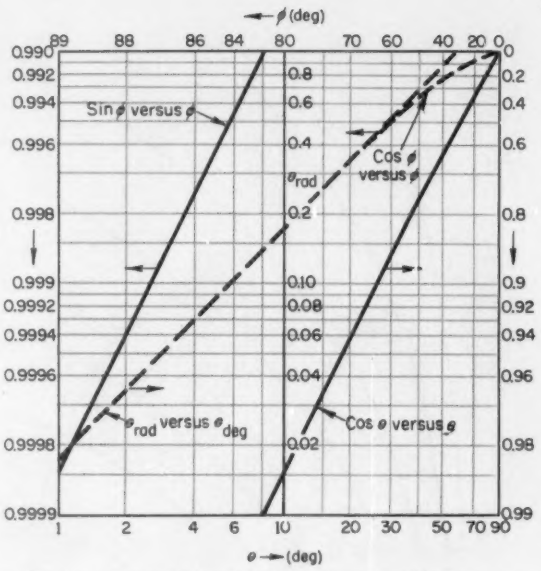

Fig. 11—Log-log plots of sine and cosine functions.

ACKNOWLEDGMENT

The author wishes to express his appreciation to Frederick W. Brokaski, Ronald S. Kareken, Charles N. Lynk, Daniel W. Murphy, and Francis J. Spokas for preparing the drawings and assisting with the preparation and checking of the equations.

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Tips and Techniques

Checking Gear Sizes

The wire-measurement specification for a gear sometimes calls for a nonstandard wire diameter. A new measurement can be determined for a standard wire, if the two diameters do not differ by more than 0.010 in.

1. Determine pressure angle ϕ at point of contact for original pin.

$$\cos \phi = \frac{D_B}{M_P - D_p}$$

where D_B = diameter of base circle; M_P = original pin measurement; D_p = original pin diameter.

2. Calculate

$$x = \frac{D_{p1} - D_{p2}}{\sin \phi}$$

where D_{p1} = larger pin diameter; D_{p2} = smaller pin diameter.

3. Solve

$$Y = \pm 2x + M_P - D_p$$

4. Then

$$M_{PN} = Y + D_{pN}$$

where M_{PN} = new pin measurement; D_{pN} = new pin diameter.—R. J. BYERWALTER, *executive engineer, Brad Foote Gear Works Inc., Cicero, Illinois.*

C. G. of Fillet

The equation for finding the center of gravity of a 90 deg spandrel or fillet ("Tips and Techniques," October 13, 1960, Page 153) should be

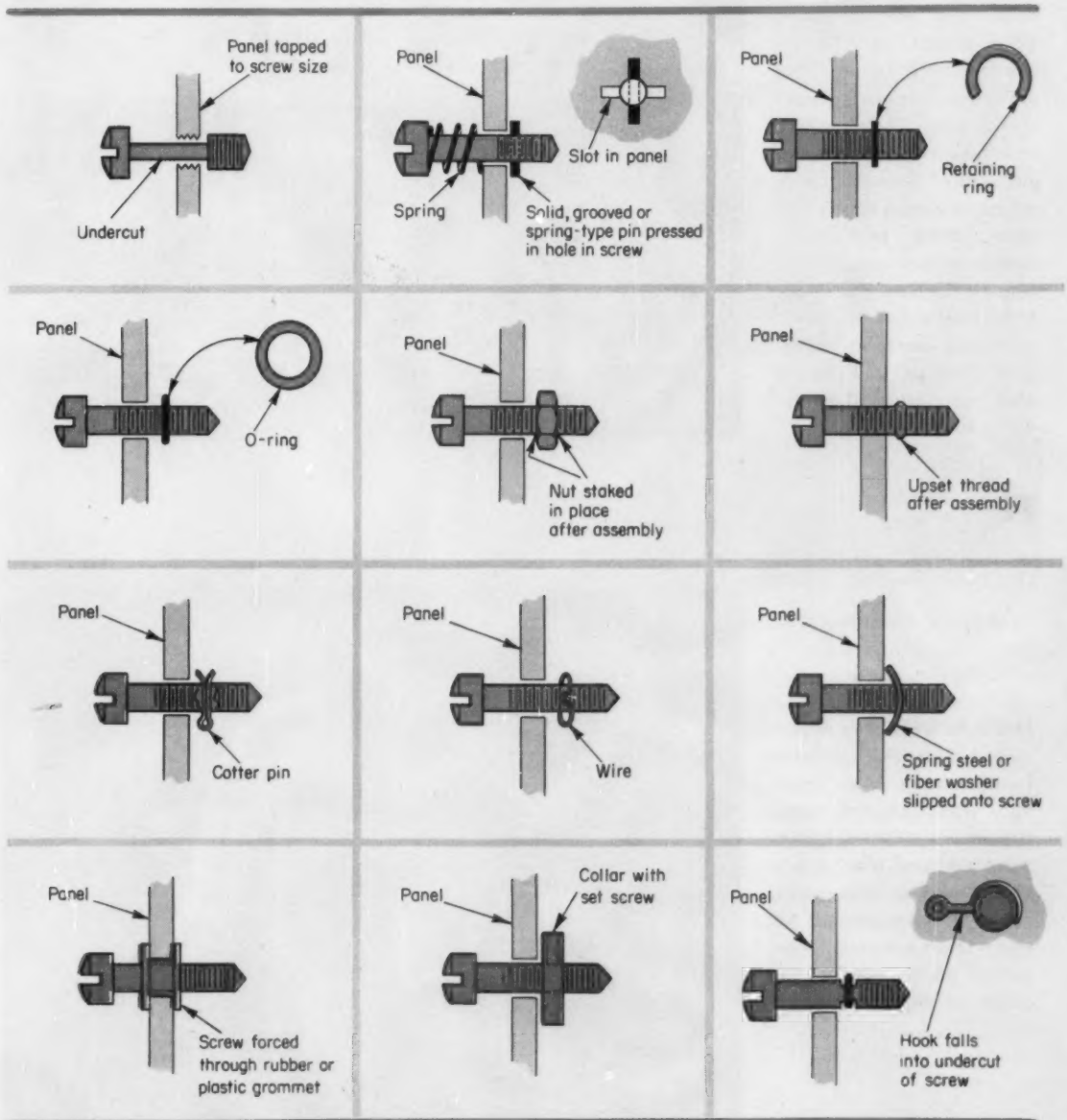
$$x = y = 0.2234\,r$$

Twelve ways of designing

Captive-Screw Assemblies

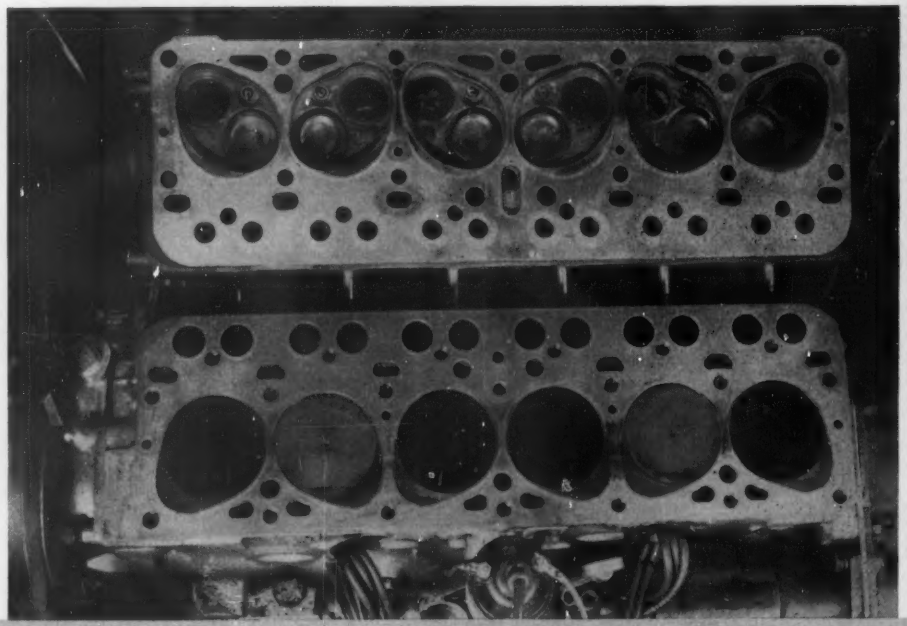
FRANK WILLIAM WOOD JR, Advanced Designs Inc., Vienna, Va.
VERNAL L. HUFFINES, Engineer, Lofstrand Co., Rockville, Md.

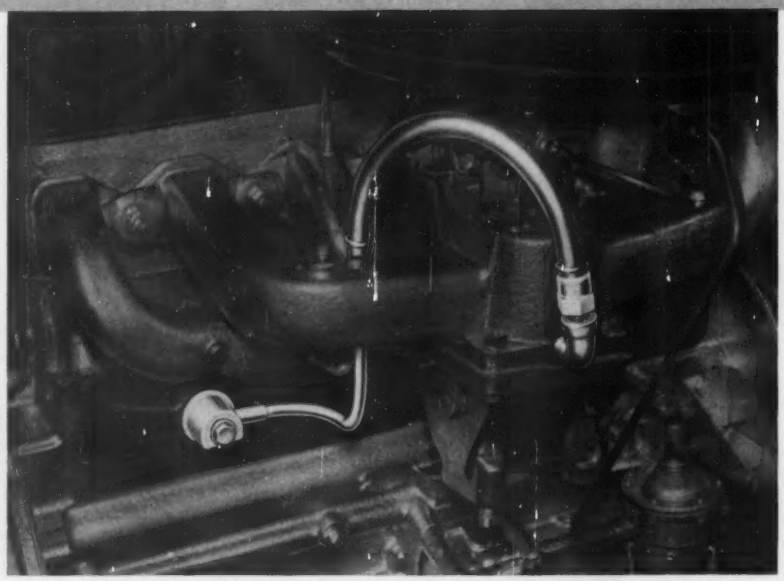
Loose screws from frequently removed panels or components are often not only a nuisance but can result in damage to equipment, particularly where moving parts are exposed. Here are a dozen ways to retain the screws in the removed panels.



Staggered Valves Increase Horsepower

INCREASED POWER in the same-size block as used in last year's engine has been designed into the new Studebaker Lark engine. Secret is a staggered arrangement of intake and exhaust valves. Kidney-shaped combustion chambers to fit the new valve configuration allow generous quench area. The result is a smooth-running engine with a minimum of detonation. Long exhaust passages through the water jacket heat water quickly to minimize cold-running time. Bore and stroke of the new engine are identical to last year's, but the engine develops 112 hp at 4500 rpm versus 90 hp for the older model.

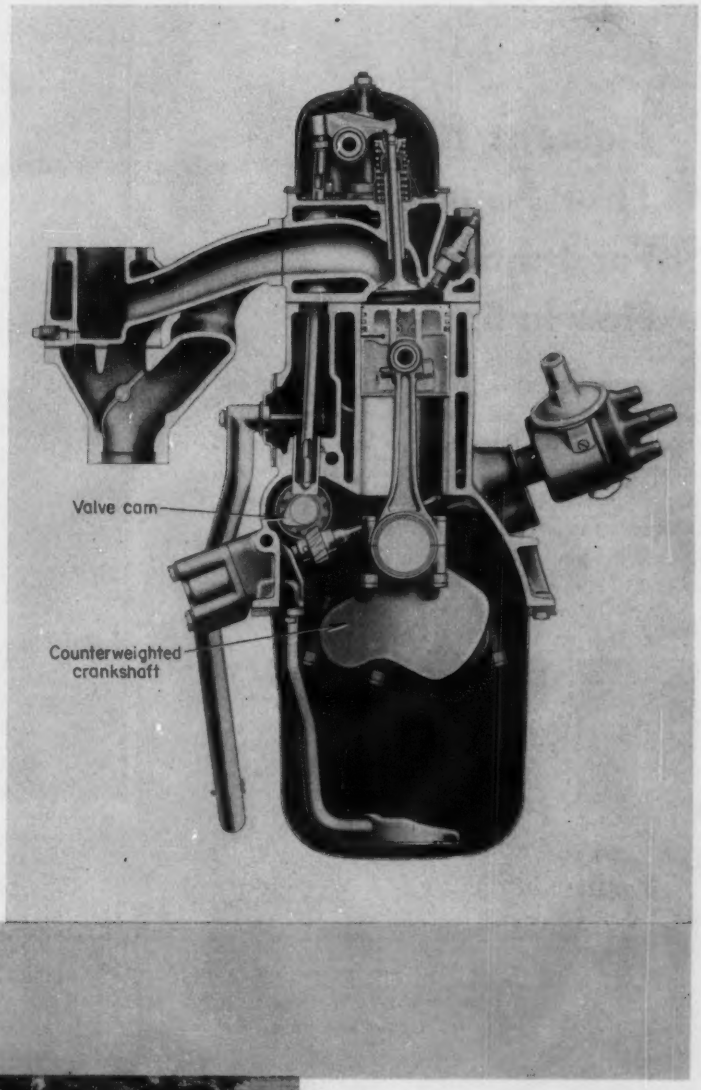




SMOG REDUCTION is accomplished by leading crankcase fumes into the intake manifold. This "positive type" crankcase ventilation system was developed after it was discovered that these fumes, rather than the exhaust, account for a substantial proportion of the total hydrocarbon emissions from a car.

In Lark Engine

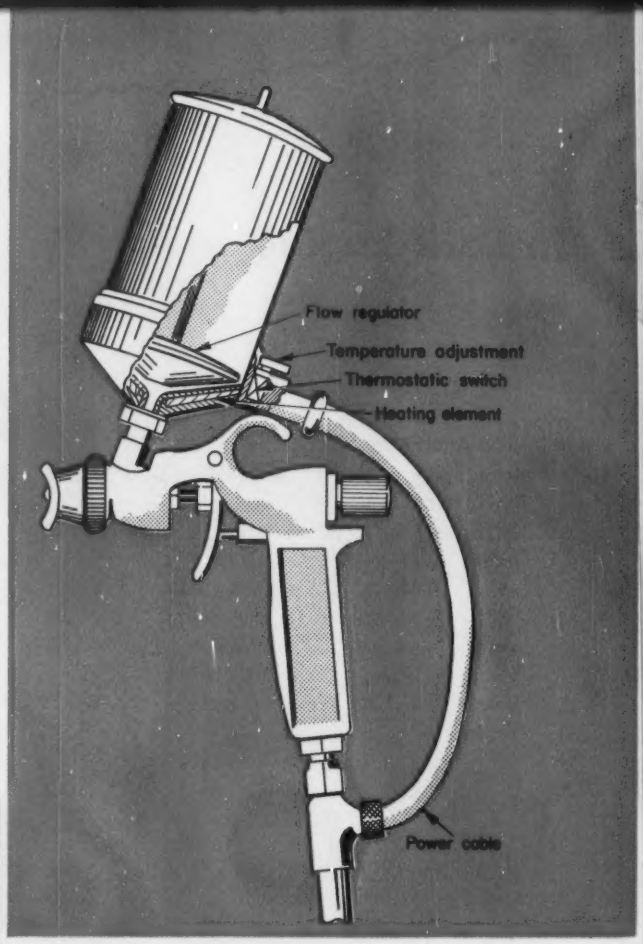
LOW-ACCELERATION CAM with a long ramp is claimed by Studebaker to permit the use of relatively lightweight valve springs, and to reduce noise as the cam picks up valve clearance. Crankshaft is fully counterweighted for fine engine balance with little drive-line vibration. Timing gears (not shown) have replaced the previously used timing chain.

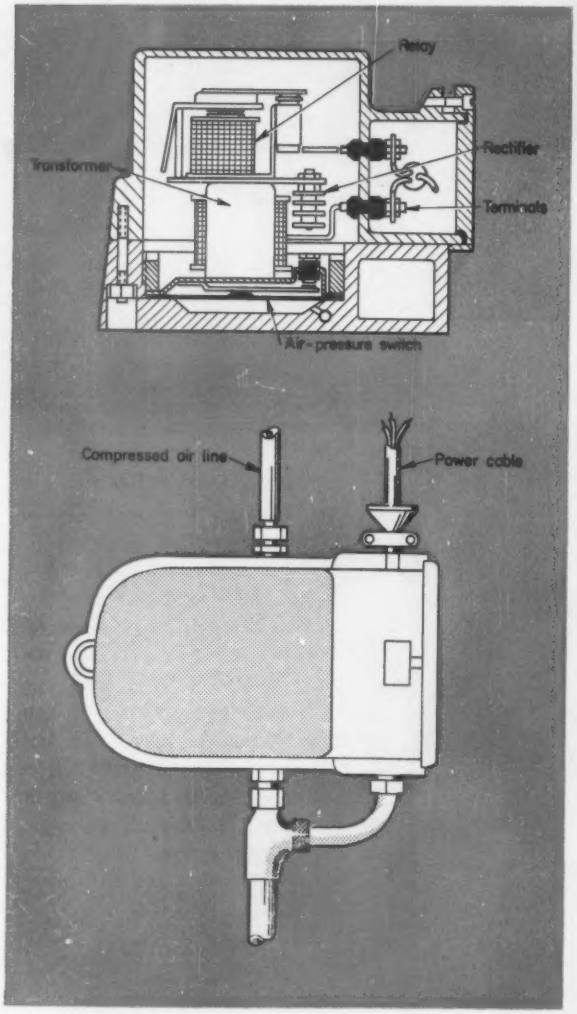


MODEST REFINEMENTS in styling of the '61 Lark provide subtle improvements without changing the character of the car. Cowl is lowered 2 in.; windshield and rear window enlarged, to improve visibility. Roof, upper deck, and rear deck have all been lowered 1 in. for improved proportions. Decorative touches, to relieve the car's severity, include sculptured lines on the hood, rear deck and along the sides, and louvres on the upper rear quarter section.

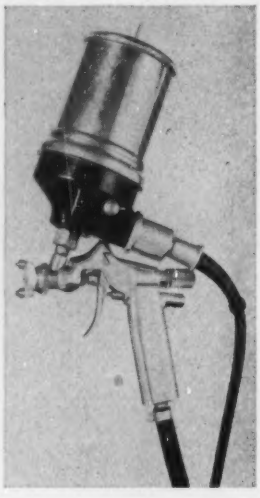
Element Heats Thin Paint Film For Improved Flow In Spray Gun

EVEN FLOW OF FINISH in a new spray gun is produced by warming the material just before it enters the spray nozzle. Flow regulator is a cone-shaped mandrel that keeps the finish flowing in a thin film over the funnel-shaped heating surface. A thermostatic switch maintains optimum temperature for easy flow of the material. Temperature can be adjusted up to 210 F, to suit it to most sprayed material.

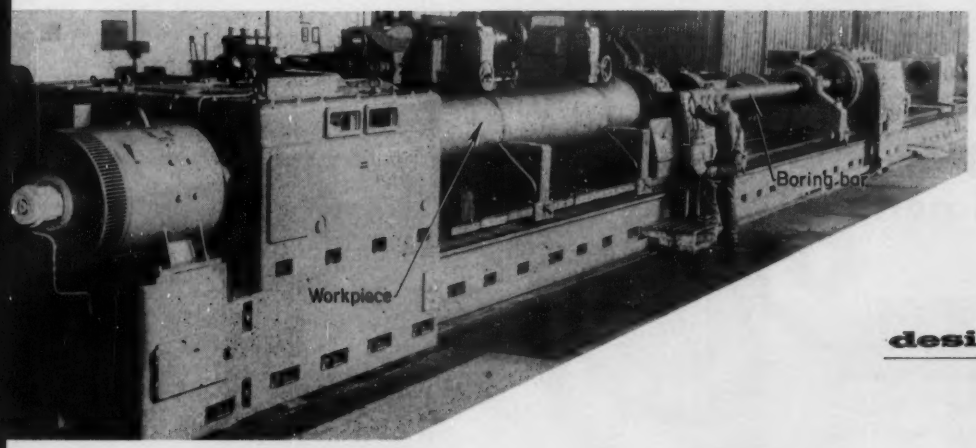




TO AVOID BAKING FINISH when spray gun is not being operated, change in air pressure, from operation of the gun trigger, actuates an air pressure switch. Transformer and rectifier produce 24 v dc for the heater.



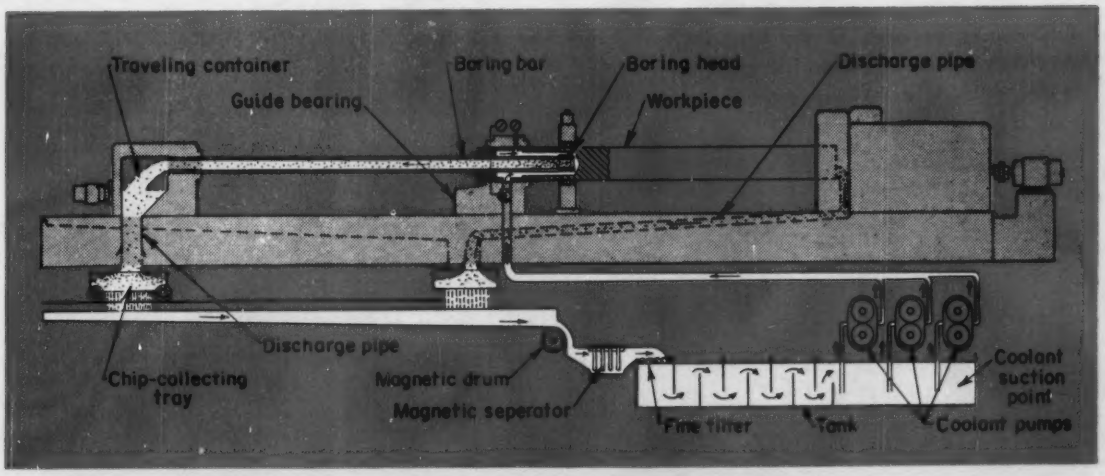
HAND-HELD UNIT INCLUDES gun, heating unit and a small paint reservoir. Spray gun with the heating unit, called Colortherm, was designed by Edgar Angst, Ehingen/Donau, Germany.

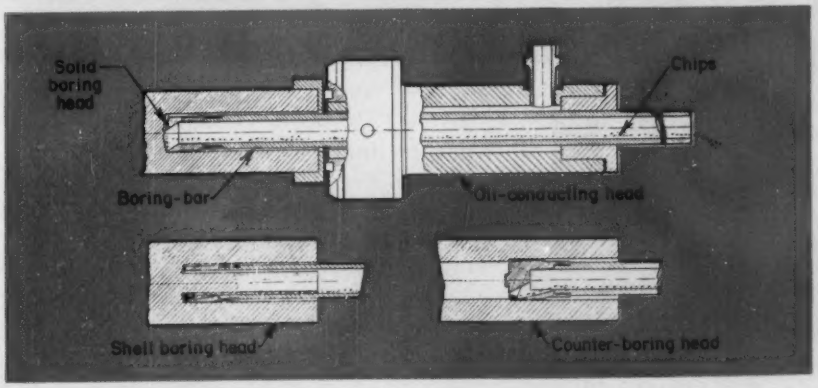


BORE DEPTHS more than 100 times bore diameter are obtainable with new reverse-flow boring bar. Design is by Wagner & Co., Dortmund, Germany.

Reverse Flow of Chips Saves Surface Finish

BORING BAR IS DESIGNED to draw coolant through its hollow shank, a reversal of usual procedure. Instead of being flushed out over the lip of the hole being bored and possibly scratching the mirror finish of the hole wall on the way, chips follow the coolant up the center of the boring bar. They are removed by screens and magnetic separators.

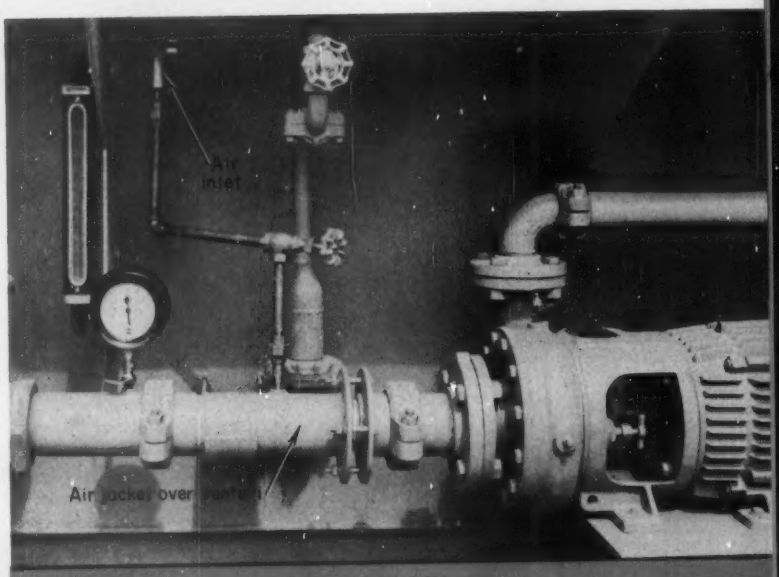




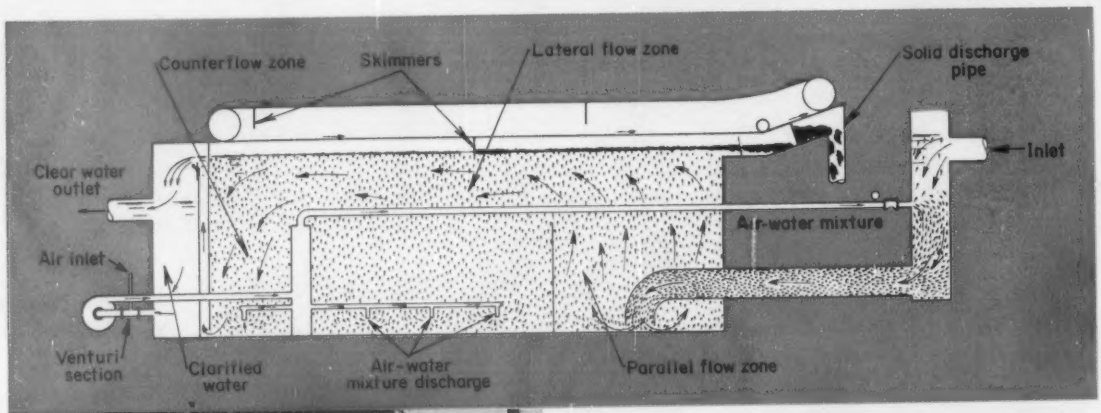
OIL - CONDUCTING HEAD seals incoming coolant between stationary and rotating members. It acts like a bushing for the boring bar. A variety of cutting heads for various operations have been designed using the reverse-centerflow design.

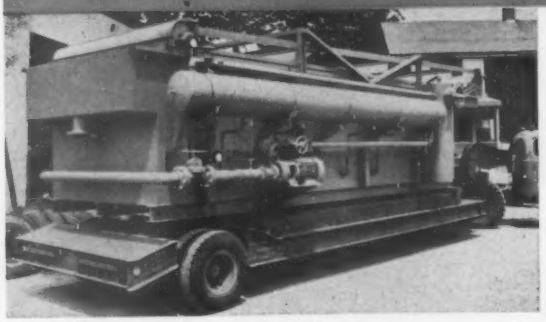
Stone Throat Aerates Fluid In Water Clarifying Tank

STONE VENTURI section diffuses minute air bubbles into water stream. Pressure drop in the constricted section draws air through the slightly porous stone. Tiny bubbles formed on the inner wall of the stone throat are swept into the stream by the fast-moving water. Air bubbles float away contaminating solids.



SOLIDS FLOAT out of suspension when air bubbles fasten to them. Rising water in parallel flow zone accelerates solids to the top of the tank. More air bubbles attach to the solids in the lateral flow zone and counterflow zone. Clarified water leaves the tank at the bottom while skimmers on an endless belt guide floating solids to a discharge pipe.

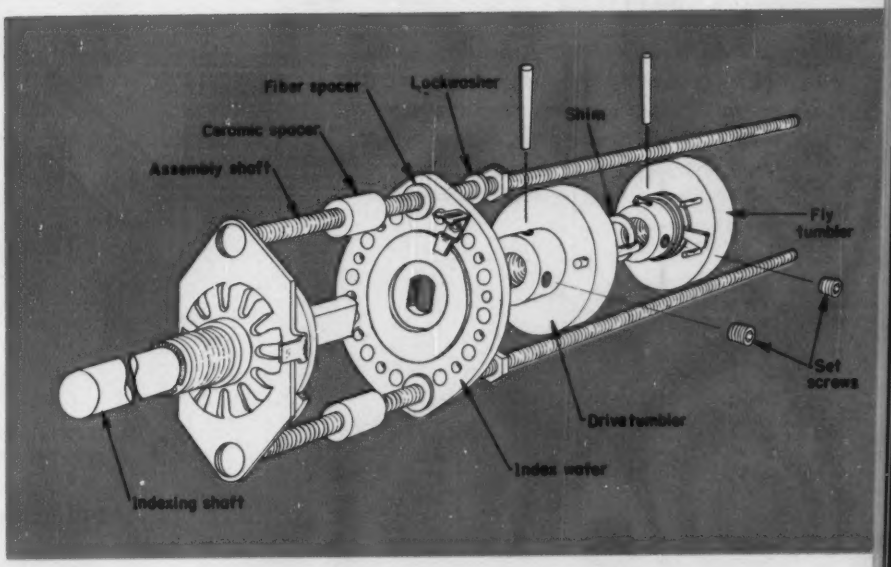


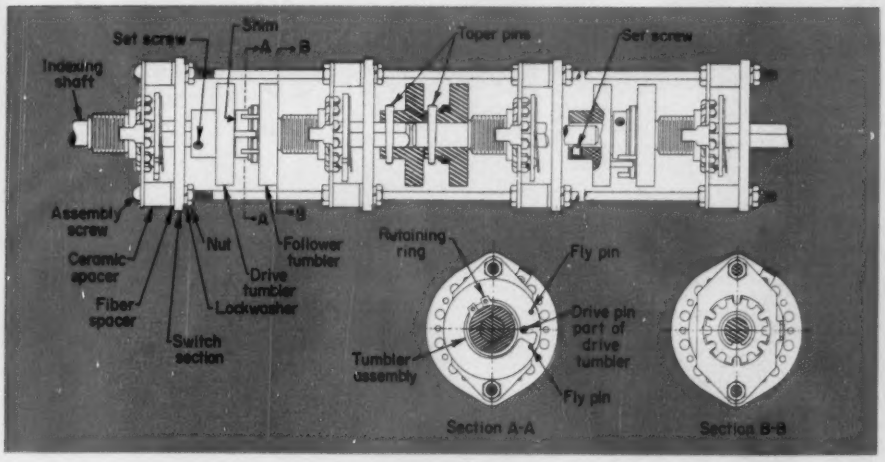


FLOTATION UNITS are made in seven sizes to clarify waste fluids at 50 to 1250 gpm. Developer, Komline-Sanderson Engineering Corp., Peapack, N.J., uses a standard Ingersoll-Rand Motorpump to circulate the water-air mixture.

Electromechanical Memory Switch Borrows Tumbler Principle from Combination Safe Lock

NUMBERS ARE STORED on index wafers in a device resembling a combination lock and operating in much the same way. Each stage of the switch, representing one decade, has an index wafer and a drive tumbler moving with it to operate the next stage. The wafer has twelve index positions—for plus and minus signs and digits 0 through 9. All stages after the first are operated by a fly tumbler driven by the drive tumbler of the preceding stage.

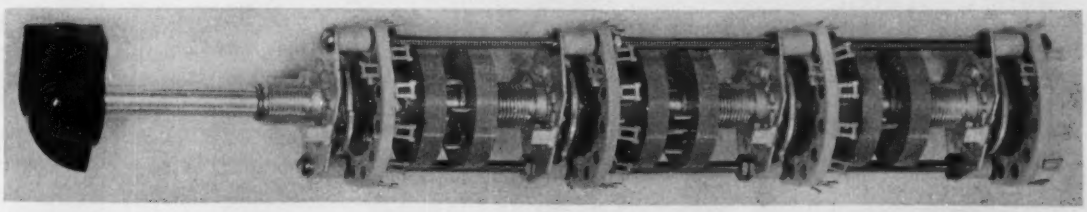




Here's how it works:

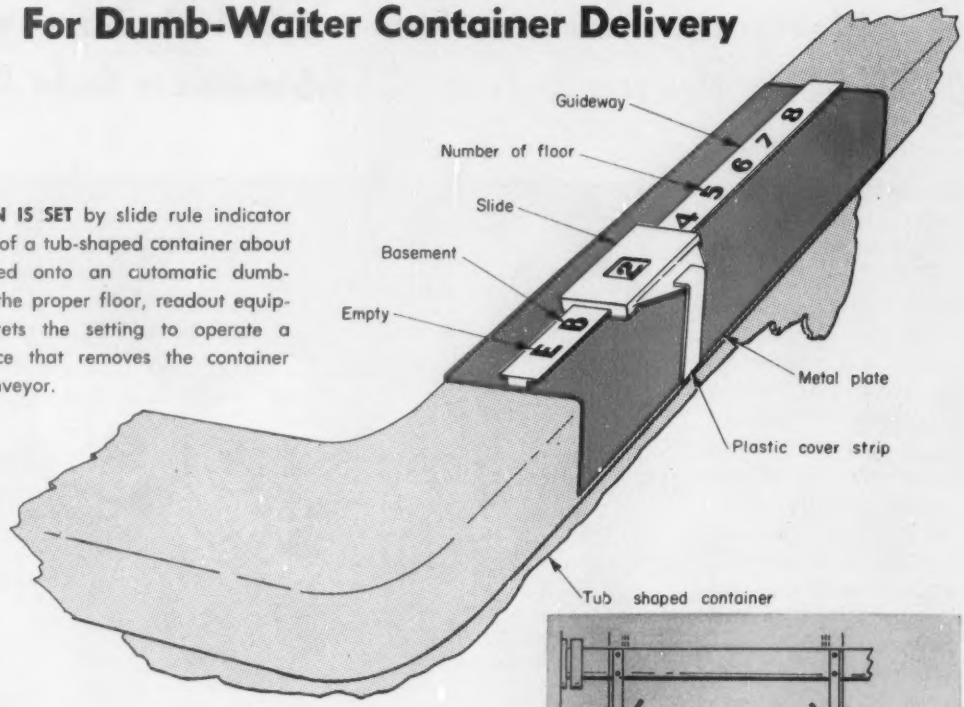
- The four-digit decade switch is loaded by turning four complete revolutions in one direction to be sure all flies and pins are engaged.
- The operator continues to turn in the same direction to the first number selected.
- Direction of turn is reversed and the pointer is turned until it has passed the set number the third time.
- The pointer is stopped at the second number selected.
- Each digit is selected in the same way. The knob is reversed and turned one fewer turns to load it for each subsequent decade.

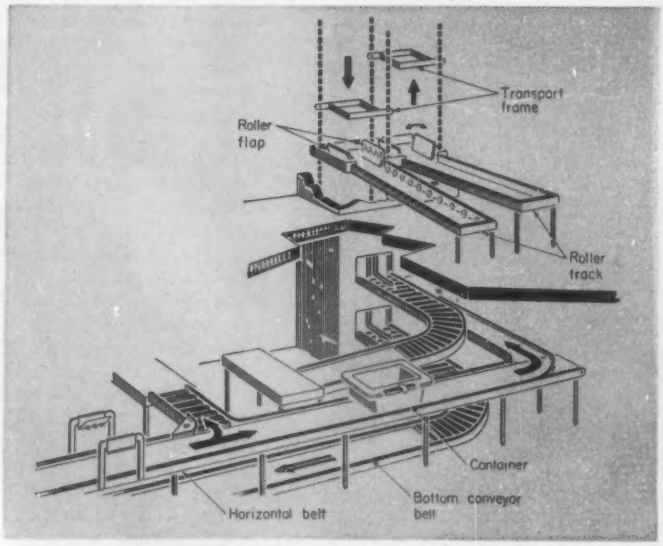
N-DIGIT DECADE SWITCH was developed to simplify automatic control of electric currents used in testing gyroscopes. It would reduce the number of switches used in any automatic control system, says the developer, Paul D. Shannon of MIT's Instrumentation Laboratory.



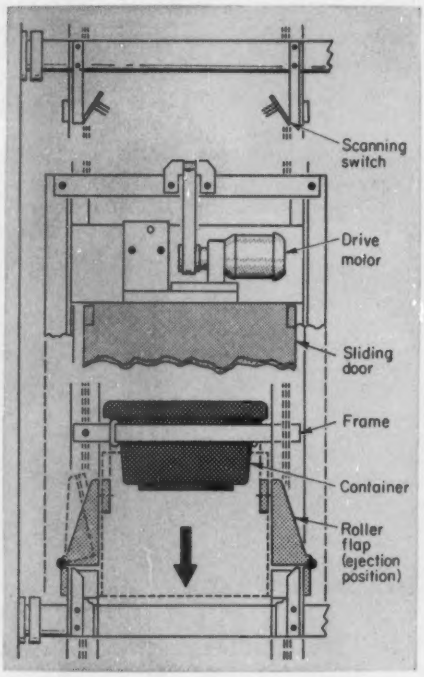
Slide-Rule Indicator Selects Floor For Dumb-Waiter Container Delivery

DESTINATION IS SET by slide rule indicator on the edge of a tub-shaped container about to be loaded onto an automatic dumb-waiter. At the proper floor, readout equipment interprets the setting to operate a pickoff device that removes the container from the conveyor.



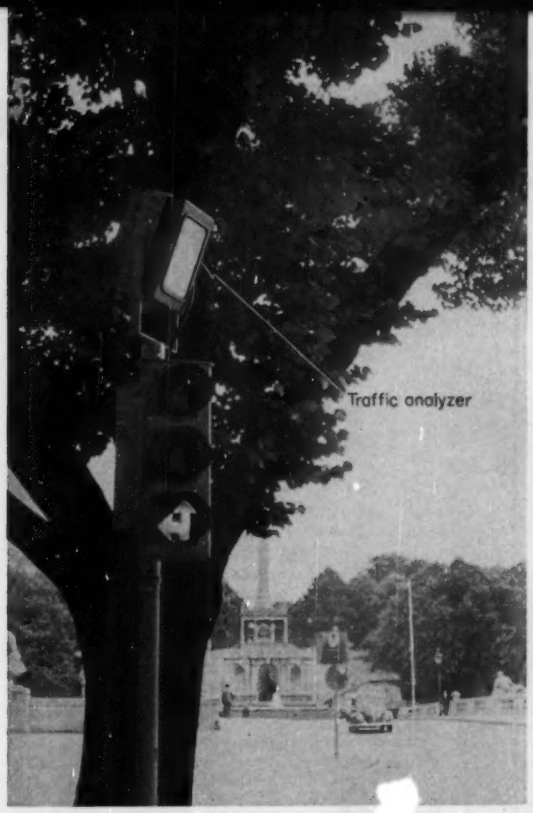


ADDRESSED CONTAINERS RIDE the conveyor system until roller track at the address has room for them. Empties are returned to storage on the lower basement receiving track. Loaded containers slide onto roller flaps and are picked up by an empty frame. Manual operations consist of loading and unloading containers, and setting the sliderules. The system, a design of Siemens & Halske AG, Munich, Germany, is used for library book delivery.

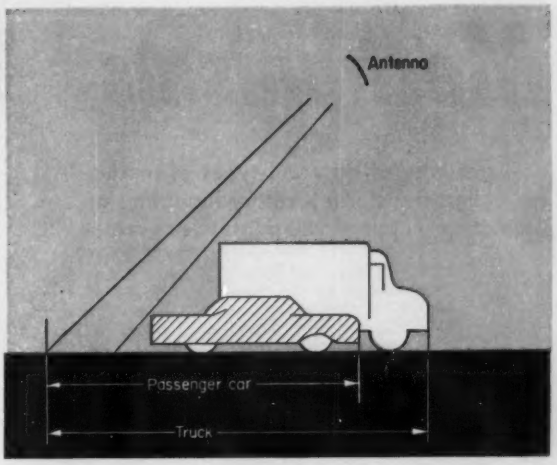


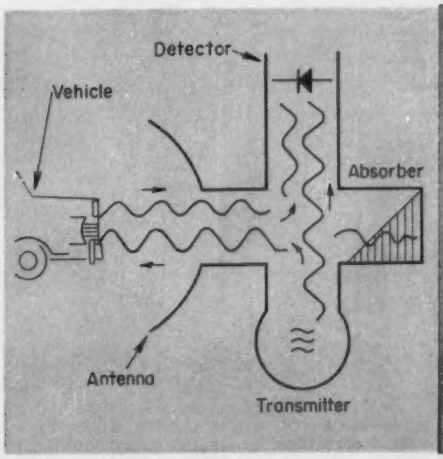
SCANNING SWITCH IS PLACED in a position corresponding to its address. The switch triggers a drive motor that raises a sliding door and rolls two flaps into position to pick the container from the descending frame. The container slides on its flange along the inclined flap top and drops onto the receiving roller track. An electronic sensor nulls signal if the truck is full.

Radar Traffic Scanner Uses Doppler Principle To Classify Traffic

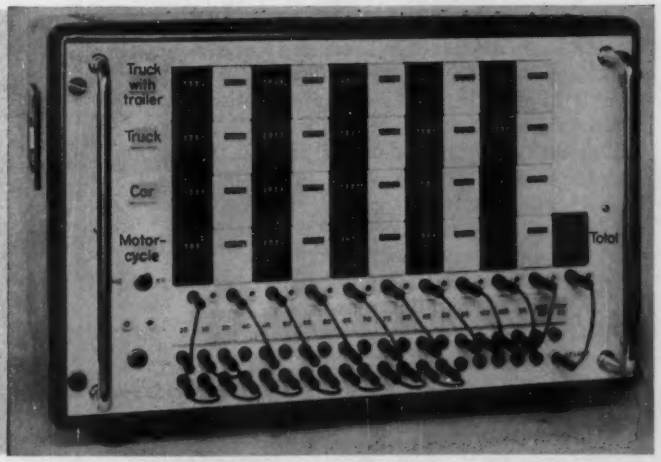


PERCHED HIGH ENOUGH above traffic to get an angled view of each vehicle, a radar scanner uses a combination signal to classify the vehicle: A doppler signal indicates vehicle speed. This is combined with an elapsed-time measure to give a combined length and height indication. The resulting information is sufficient to lump the vehicle in one of four categories—motorcycle, car, truck, or truck-with-trailer. Category and speed are recorded for traffic surveys.





DOPPLER EFFECT causes an interference beat when the reflected wave is combined with the original signal in the receiver. Frequency of the beat is a measure of the car's speed. The meter counts number of doppler-interference beats to determine car length.



TOTAL BEAT COUNT DETERMINES which of four registers will record the signals. Speed determines how far to the right in each register the count will be made. Digital counters thus keep a running record of vehicles in each speed-size category. Errors in the system are said to be less than 3 per cent. Traffic analyzer is a development of Telefunken GmbH, Ulm/Donau, Germany.

Design details and performance characteristics of

Large-Oscillation Mechanisms

. . . a survey of different types of mechanisms that transform a rotary input into an oscillating output of 180 degrees or greater

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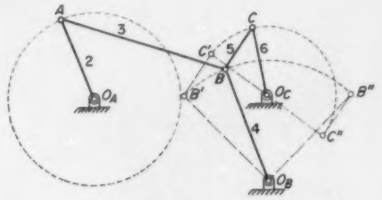
LINKAGES are often used to convert a rotating input motion to an oscillating output. For such mechanisms, a high level of precision can be achieved in design with methods that have already been developed.[1] These methods, however, are limited to output crank oscillations that are less than 180 deg. When the angle of oscillation reaches 180 deg, the connecting rod and output crank must assume an inline or dead-center position. An auxiliary force must then be added to the output link if the mechanism is to operate. Additionally, the acceleration characteristics under these operating conditions become extremely poor.

In this article, attention will be given to the various types of mechanisms that will give an output oscillation close to and greater than 180 deg. Various mechanisms of this type have been developed; however, little information is available in the way of comparative data on the different designs for such characteristics as accelerations, transmission angles, and design requirements. Schnarbach[2] has dealt briefly with the subject but has limited himself to mechanisms that are composed entirely of linkages. This excludes the large family of mechanisms that are composed of cams, gears, or any combinations of the three basic components.

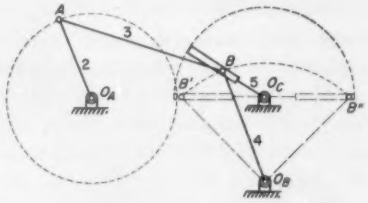
In this article, no attempt is made to give a

[1]References are tabulated at end of article.

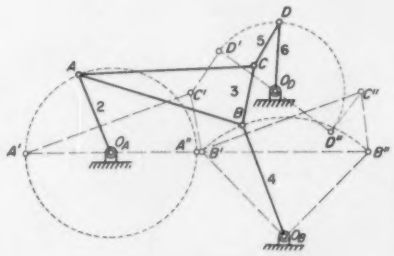
Pure Linkage Combinations



Two Linkages in Series (Conventional Crank)
This mechanism consists of two four-bar linkages in series. The input linkage converts a rotating input to an oscillating output of less than 180 deg. The second linkage increases the magnitude of the output oscillation of the initial four-bar.



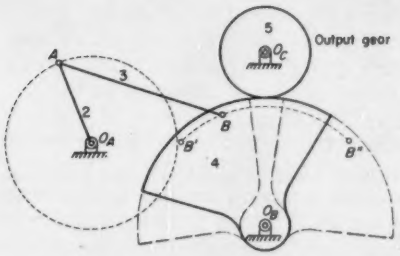
Two Linkages in Series (Slotted Crank)
This mechanism is a special case of the design which uses two linkages in series with a conventional output crank. It has a slotted output crank which is equivalent to an infinite connecting rod on the output four-bar.



Coupler Drive
In this design the output crank is driven from a point on the coupler of the initial linkage. It may be driven by a finite connecting rod or a slotted crank.

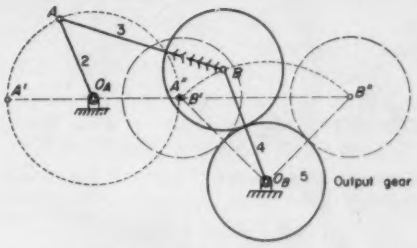
Table 1—Mechanisms for Large Oscillating Output

Linkage-Gear Combinations



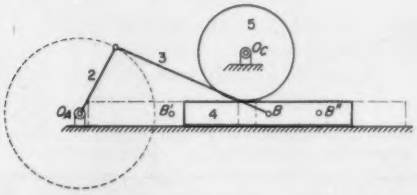
Gear-Linkage Series

In this design the input is a four-bar linkage with the output crank replaced by a gear sector. This gear in turn drives the output gear.



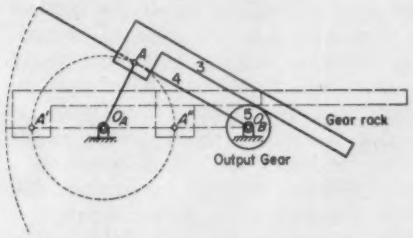
Epicyclic Geared Linkage

This design consists of a gear sector which is fastened to the connecting rod of the linkage and drives an output gear concentric with the pivot of the output crank of the linkage.



Slider-Crank Gear-Rack Combination

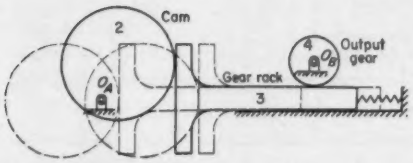
This design is a special case of the gear-linkage series. The output of the linkage is a gear rack that drives the output gear.



Epicyclic Geared Linkage with Gear Rack

This design is a special case of the epicyclic geared linkage in which the linkage has an infinite connecting rod and the connecting rod gear is replaced by a gear rack. The output gear remains concentric with the output pivot of the linkage.

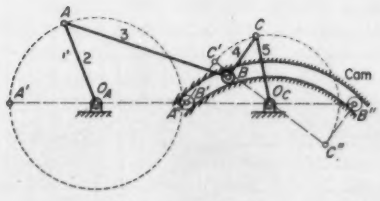
Gear-Cam Combination



Cam-Driven Gear Rack

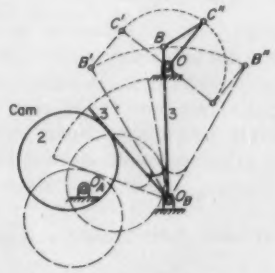
This mechanism uses a rotating cam to drive a gear-rack that in turn drives the output gear. Another possible design would replace the rack by a gear sector of finite radius. The cam-driven rack may be considered a special case of this design.

Cam-Linkage Combinations



Cam-Corrected Linkage

In this mechanism, the intermediate crank of the design using two four-bars in series is replaced by a stationary cam surface. The cam can exactly replace the motion of the crank or it can modify the motion.



Cam-Driven Linkage

In this design the input crank is driven by a rotating cam. The cam causes the input link to oscillate through an angle less than 90 deg. The linkage increases the oscillation to its desired value.

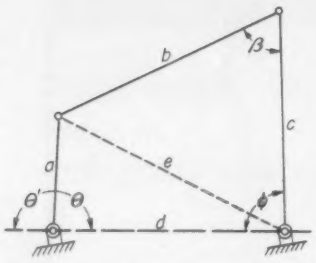


Fig. 1—Construction for analytical linkage analysis.

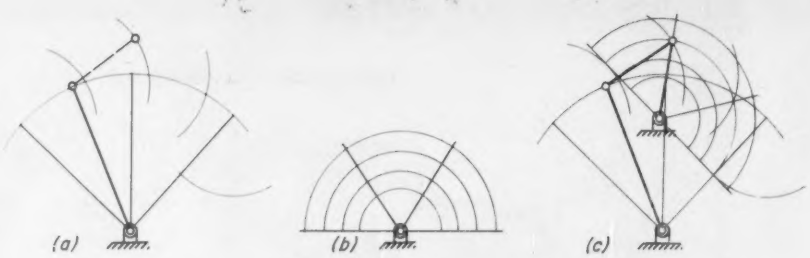


Fig. 2—Overlay method of linkage design. Layouts at *a* and *b* are drawn on separate sheets and then fitted together, *c*, to find required linkage proportions.

Large-Oscillation Mechanisms

thorough and detailed analysis of all the possible mechanisms that will give this type of motion. Rather, major attention is given to those types of mechanisms which will, in all probability, find the widest practical use. Emphasis is also given to mechanisms that belong to broad groups rather than those that are highly specialized in nature.

A number of different types of mechanisms that are capable of transforming a rotary input to a large oscillating output are shown in Table I. Design requirements and performance characteristics of these mechanisms will now be considered in detail.

Pure-Linkage Combinations

Two Linkages In Series (Conventional Output Crank): For oscillating linkages using two four-bar linkages in series, design of the initial or input four-bar is of key importance. This linkage determines the time ratio of forward to return swing of the output crank.

Design techniques for linkages of the type needed to perform this input function (rotating input with oscillating output < 180 deg) are well-established and have been covered elsewhere.[1] It should be kept in mind, however, that in general a longer connecting rod will give lower peak values of acceleration.

The second (output) four-bar linkage of the series pair has no effect on the previously mentioned time ratio for the over-all mechanism. However, design of this linkage is not as well defined as that of the input four-bar. Several design techniques, including both analytical and graphical methods, can be used for this linkage. Three of these methods will be considered here.

The first method uses Freudenstein's equation.[3] From Fig. 1,

$$R_1 \cos\theta - R_2 \cos\phi + R_3 = \cos(\theta - \phi)$$

where,

$$R_1 = d/c$$

$$R_2 = d/a$$

$$R_3 = 2ca\,(d^2 + a^2 - b^2 + c^2)$$

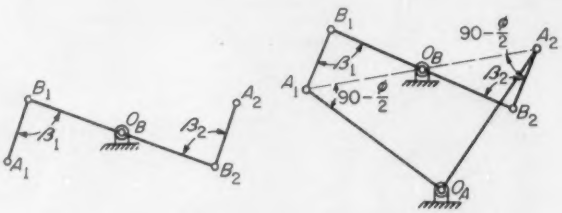


Fig. 3—Direct construction of output four-bar linkage in series arrangement.

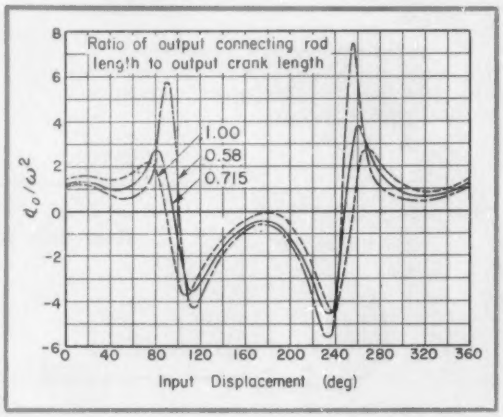


Fig. 4—Acceleration characteristics for two four-bar linkages in series with rotating input and 180 deg oscillating output. Plots correspond to designs with different ratios of output connecting rod length to output crank length. Acceleration values are expressed in terms of the dimensionless ratio, α_o/ω^2, where α_o = output acceleration and ω = input velocity.

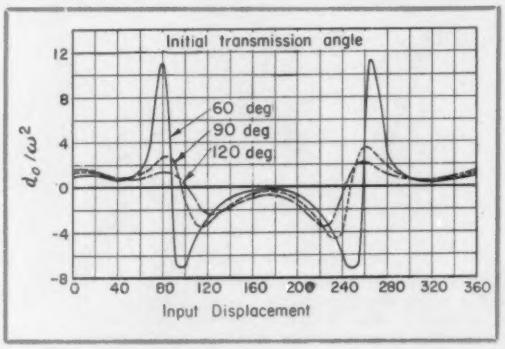


Fig. 5—Acceleration characteristics for two four-bar linkages in series with rotating input and 180 deg oscillating output. Plots correspond to designs with different initial transmission angles.

Use of this equation permits the linkage design to meet the desired input-output curve at five precision points. The primary disadvantage of this purely analytical approach is that the resulting linkage design, while it meets five precision points, may not be practical from the standpoint of transmission angles and relative linkage dimensions.

A second graphical technique that finds wide application is the overlay method, Fig. 2. It is easy to use and provides fairly good accuracy. In this method a convenient length is chosen for the input crank which is then drawn in its required input positions on tracing paper. A length for the connecting rod is chosen and a family of arcs is drawn using this length as the radius and the crankpin positions as the centers, Fig. 2*a*. On a second sheet of paper another layout is made of the output crank in its successive positions, and concentric circular arcs are drawn to show possible crank lengths, Fig. 2*b*.

By positioning the first drawing over the second and trying to make the connecting-rod arcs of the first drawing pass through a possible series of output crank positions on the second drawing, a suitable mechanism may be found, Fig. 2*c*. If not, the process should be repeated using a different length of connecting rod.

A third method of linkage design uses a technique that correlates the positions of the input and output cranks at the ends of the cycle. It permits the designer to select the transmission angles at the ends of the cycle, as well as the connecting-rod length. In this method, the output crank is drawn in its two extreme positions and the connecting rod is drawn in position at the desired transmission angles, β_1 and β_2. This construction, Fig. 3, uniquely determines the location of pivot O_A of the input crank.

This technique may appear to provide little control over the acceleration characteristics of the mechanism. However, it was found that good acceleration characteristics will usually result if the linkage is designed with suitable transmission angles at the ends of the motion cycle.

Pure-Linkage Analysis: For comparison, various designs of this type of mechanism were investigated. Initial or input four-bar linkage was made the same for all designs with an output crank oscillation of 90 deg, a time ratio of forward to return stroke of 1:1, and a ratio of input connecting rod length to output crank length of 3.5:1. Over-all mechanism in each case had a total output oscillation of 180 deg.

Effect of output connecting-rod length on the output accelerations and transmission angles was investigated first. Three mechanisms with connecting rods of varying length (short, long, and intermediate) were designed. All three mechanisms were designed with transmission angles of 90 deg at both ends of the oscillation cycle. These angles will be referred to here as the initial and final transmission angles.

Results are summarized in Fig. 4 which shows that the longer the connecting rod the lower the maximum value of acceleration. However, note that there is relatively little difference between the maximum accelerations for the long and intermediate-length connecting-rod designs while the extreme value of acceleration for the linkage with a short connecting rod is much higher.

Comparisons were also made of the effect of initial and final transmission angles on output acceleration. In the design investigated, final transmission angles were kept at 90 deg and the initial transmission angles were varied from 60 to 120 deg. To permit comparison of the various mechanisms, the ratio of output connecting rod length to output crank length was held constant.

Results are plotted in Fig. 5. Best acceleration characteristics were obtained with the design in which the initial transmission angle was greater than 90 deg. Worst results were obtained with an initial angle less than 90 deg.

To further investigate the effect of initial and final transmission angles on mechanism performance, the initial angle was held constant at 120 deg and the final angle was varied. Results were quite surprising. Variations in the final angle had negligible effect on the values of acceleration. There

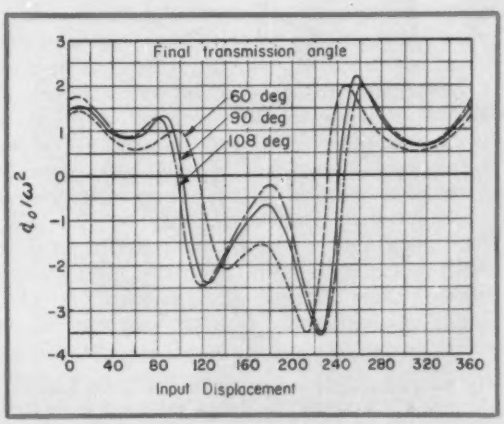


Fig. 6—Acceleration characteristics for two four-bar linkages in series with rotating input and 180 deg oscillating output. Plots correspond to designs with different final transmission angles.

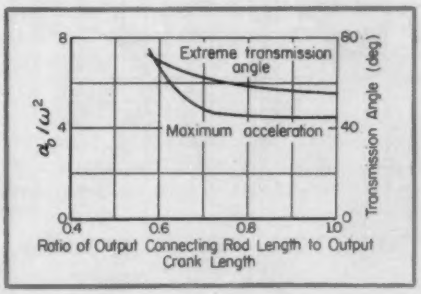


Fig. 7—Relationship of acceleration characteristics and transmission angle to connecting rod length in output linkage of pure-linkage series with rotating input and oscillating output.

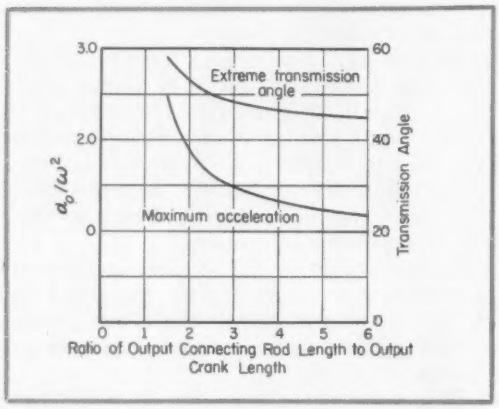


Fig. 8—Relationship of acceleration characteristics and transmission angle to connecting rod length in four-bar linkage with rotating input and oscillating output.

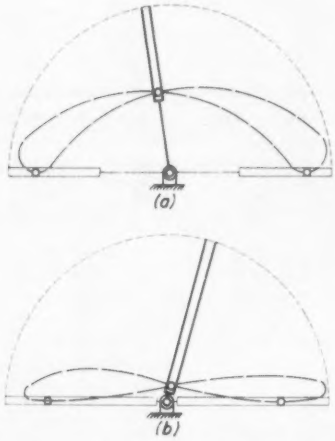


Fig. 9—Two coupler curves for coupler-driven linkages. Curve at *a* is acceptable for design, curve at *b* is too flat.

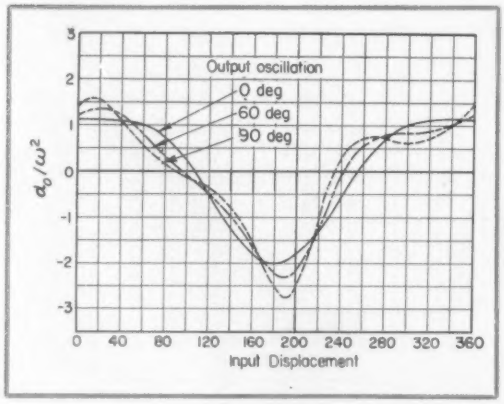


Fig. 10 — Acceleration characteristics for gear-linkage series with rotating input and 180 deg oscillating output. Plots correspond to different angles of oscillation of the linkage output crank.

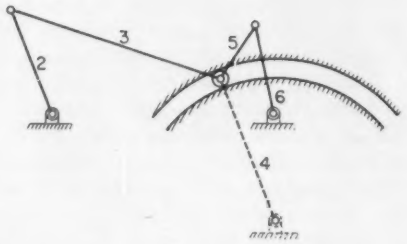


Fig. 11—Modified design of pure-linkage series with crank replaced by stationary cam.

was some difference, Fig. 6, but it was extremely small.

One noteworthy finding of these investigations was the close relationship between transmission angles and values of acceleration. In Fig. 7, maximum value of acceleration and extreme value of transmission angle are plotted against connecting rod length for the output linkage. Although not of the same shape, the curves follow the same general trend. Similar plots for the input four-bar linkage, where the input acceleration is zero, appear in Fig. 8.

Two Linkages in Series (Slotted Output Crank): Design of two linkages in series for the special case where the output crank is slotted is much simpler than for the previous general case. Total output oscillation for any particular input linkage is dependent only on the position of the pivot for the output crank (O_c). For this linkage arrangement, Table 1, a two-step design procedure can be used: 1. Draw the output crank of the initial four-bar in its extreme positions (O_BB' and O_BB''). 2. Select a location for the fixed pivots so that lines drawn to the crankpins (O_cB' and O_cB'') are at the extreme positions corresponding to the desired total output displacement.

For oscillations greater than 180 deg the pivot, O_B must fall inside the arc determined by the motion of the crankpins. For this reason, when mechanisms of this type are designed for large output angles, the input four-bar linkage should have a relatively large oscillation angle so that the final output crank does not become too short in the center of its oscillation.

Coupler Drives: For mechanisms using a coupler drive to develop large output oscillation, design is most easily accomplished with a catalogue of coupler motions.[4] After a suitable coupler motion is selected from the catalogue, the design procedure is essentially the same as for two four-bar linkages in series. If the output crank of the mechanism is to be driven by a connecting rod of finite length, the easiest design approach is an overlay method similar to that described previously. When a slotted output crank is used, connecting-rod length becomes infinite and design depends directly on the particular coupler curve selected. In such situations, one precaution should be observed in selecting a coupler curve. If the curve is too "flat" the output

crank may become too short in the middle of its motion. This condition is illustrated in Fig. 9.

Linkage-Gear Combinations

Gear-Linkage Series: Design of a gear-linkage series depends directly on the input-linkage design. The only other requirement is that the gear ratio (input/output) must be inversely proportional to the ratio of linkage output displacement to total output displacement. Then, the ratio of angular acceleration of the output gear to that of the linkage output crank is directly proportional to the ratio of linkage output displacement to total output displacement and inversely proportional to the gear ratio.

Effect of displacement ratio on acceleration characteristics of these mechanisms was investigated. Three designs with 180 deg total output oscillation and the same ratio of input crank length to connecting rod length were compared. Linkage output crank oscillation was 90 deg for one design, 60 deg for another. Third design was a crank and slider with a gear rack (See Table 1), giving an effective crank output displacement of zero degrees. Results are plotted in Fig. 10. Lowest values of acceleration were developed by the slider-crank and the highest values by the linkage with a 90-deg crank output.

Epicyclic Geared Linkage: One of the more compact mechanisms for producing large oscillating output motions is the epicyclic geared linkage. This linkage, as will be shown later, has the best acceleration characteristics of any pure-linkage or linkage-gear combination, with the exception of the slider-crank gear-rack arrangement. However, design of these mechanisms is not as straightforward as for other gear-linkage systems.

In an epicyclic-geared linkage, motion of the output gear is a product of two motions: 1. Oscillation of the output linkage crank. 2. Motion of the connecting rod relative to the output crank. These two component motions do not reach their extreme values at the same time. This condition makes it impractical to use an analytical method in design, with the possible exception of digital computer techniques.

Best approach is to use a series of graphical approximations. Each approximation involves three steps: 1. Assume a gear ratio. 2. Plot two components of the output motion. 3. Add the components to find the over-all mechanism output. By repeating this process several times, the desired output can be determined without much difficulty.

Another characteristic of these mechanisms also can be troublesome in design. Time ratio of forward to return stroke of the over-all mechanism is not the same as that for the input linkage. The difference is usually very small and can be neglected in most instances. However, in those situations where a precise ratio is required, the design problem becomes more difficult and must be resolved by techniques beyond the scope of this article.

Table 2—Comparative Performance Analysis

Mechanism Type	α_o/ω^2
Two linkages in series	
Conventional output crank	3.465
Slotted output crank	3.285
Gear-linkage series	2.798
Slider-crank gear-rack combination	2.019
Epicyclic geared linkage	2.44
Theoretical cam design	
Constant acceleration	1.273
Harmonic motion	1.571
Cycloidal motion	2.000

α_o = Output acceleration, ω = Input velocity

Gear-Cam and Cam-Linkage Combinations

Cam-Driven Gear Rack: Design of mechanisms using a cam-driven gear rack is based primarily on the design of the cam. Acceleration of the output gear is a direct function of the gear-rack or cam follower acceleration. Procedures for the design of cams with specific acceleration characteristics may be found in standard engineering texts[5, 6, 7] as well as other sources.

Cam-Corrected Linkage: This mechanism may be considered as a modification of the design using two four-bar linkages in series. If, as shown in Fig. 11, the cam has the same radius and center of curvature as the intermediate crank of the two four-bar linkages, motion of this mechanism will be exactly the same as the pure linkage design. Major purpose of this design, however, is to modify and correct undesirable operating characteristics of the linkage. It has one advantage that is not found in most cam mechanisms. In the construction shown in Fig. 11, if the angle between the two connecting rods is kept very large, a relatively large change in cam contour will have only a small effect on the output crank displacement. As a result, precise control over the output characteristics can be accomplished with a cam of much less precision than is usually required.

However, this does not mean that any rough approximation for the cam contour can be selected and used in design. Although such an approach may correct the acceleration characteristics of the output crank, it would, in all probability, add just as many dynamic problems at the cam itself. The advantage of this design approach lies in the fact that the theoretically optimum cam, which may have poor dynamic characteristics, can often be modified to a standard cam contour of good dynamic characteristics with only a minor effect on the output of the over-all mechanism.

Comparison of Results

To permit valid comparison of the various types of mechanisms, it was necessary to standardize design wherever possible. All of the mechanisms com-

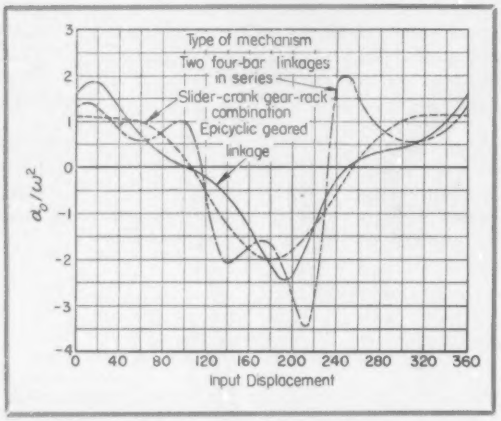


Fig. 12—Acceleration characteristics for different types of mechanisms with rotating input and 180 deg oscillating output.

pared used the same input linkage with the exception of the slider-crank design which, of necessity, did not have an output crank of finite length. With this one exception, ratio of input connecting rod length to output crank length was 3.5:1 and output oscillation of the input four-bar was 90 deg. Final output oscillation was 180 deg. Results of this investigation are summarized in Table 2 which gives maximum values of output acceleration for the mechanisms compared as a dimensionless ratio of output acceleration to square of input velocity.

Except for the design using two four-bar linkages in series, the values of acceleration given in Table 2 are the only ones for the particular input four-bar linkage used. However, these values are for comparison only and could be improved by varying the input linkage. For the design with two four-bar linkages in series, the value listed is the best one that was found. This does not mean that better results could not have been attained. In all probability, however, any improvement would be very slight. When the maximum acceleration reached this value, any further change in the design had relatively little effect. In Fig. 7, which shows the effect of connecting rod length on maximum acceleration, it can be seen that the acceleration approaches its optimum value rapidly. Further increase in connecting rod length has little effect on the results.

Although it was not included in the list, the cam driven gear rack can be designed to give any theoretical acceleration characteristics.

Design Evaluation

From the results, Table 2, it may be seen that the poorest acceleration characteristics occur in the pure linkage design. These designs can be improved, however, by the use of correcting cams as shown for the construction in Table 1. Such mechanisms do not, of course, fall into the category of pure linkages in series.

Another useful adaptation of the linkage type mechanism is the cam-driven linkage which is also shown in Table 1. Here the input four-bar is replaced by a rotating cam to achieve improved performance characteristics. These results do not mean that the pure linkage designs should be avoided. There are many instances in which acceleration characteristics are not of major importance. Often, linkages are much easier and cheaper to manufacture than cams or gears. Also, space requirements may not permit use of cam or gear mechanisms, especially those with gear racks.

Many types of mechanisms have only been mentioned briefly here. This does not mean that they are any less worthy of design consideration than those discussed in more detail. In some instances, such as the cam driven gear rack, the design was based on methods that have already been thoroughly developed. Other types, such as the cam corrected linkage, were special adaptations of other designs. The coupler drives were of such a wide variety of possible designs that they would require a study in themselves.

ACKNOWLEDGMENT

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They Say . . .

"Engineering for engineering's sake alone is completely meaningless. It must be communicated to those who are going to make use of it—that is, manufacturing, sales, services, and the customers. . . . I would venture that much more effort is expended in transmitting, controlling, and correcting design information (engineering maintenance) than in creating it. As a result, engineers are more and more becoming slaves to a clerical system and are spending a much greater percentage of their time in nonengineering work."—NORMAN J. REAM, *director of systems planning, Lockheed Aircraft Corp., Burbank, Calif.*

Fig. 1—Typical pushbutton units, stations, and enclosures.

Industrial Pushbuttons

. . . a guide to types, selection, and application of pushbuttons, selector switches, and indicating lights

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GENERALLY small, round, and equipped with a nameplate, the industrial pushbutton is a familiar electrical device. Evolutionary processes, however, have led to a wide variety of special forms which, when correctly selected, greatly increase the usefulness of the pushbutton.

Indicator lights, illuminated pushbuttons, selector switches, and key and coin-operated switches are some of the special forms identified as "pushbutton units." Several units and stations are shown in Fig. 1.

The function provided by some of the principal varieties of switches, accessories, and lights is described in Table 1.

Pushbuttons are designed for use in control and pilot circuits (see *Definitions*). In many applications they serve as the master switch in a pilot circuit. Pushbutton units are not intended for use in power circuits.

This article discusses the many different types of industrial pushbuttons available, describes typical circuit applications, and suggests criteria for selecting the most appropriate button or station to meet specific requirements.

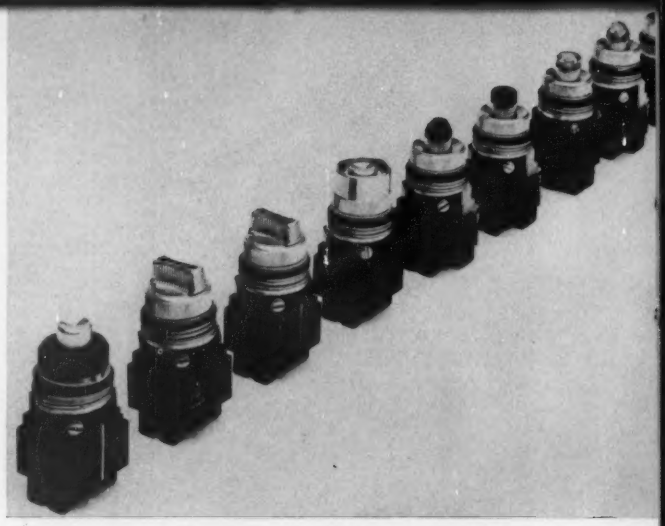


Fig. 2—New miniature pushbutton combinations and configurations.

Basic Types

Units described in Table 1 are generally available in four basic types: 1. Standard duty. 2. Heavy duty. 3. Heavy-duty oiltight. 4. Miniature oiltight.

Table 1—Functions of Pushbutton Units

Unit	Function
Pushbuttons	
1. Momentary	Provides momentary opening or closing of circuits, provides undervoltage protection.
2. Maintained	Provides maintained opening or closing of circuits, is larger and more expensive than selector switch but easier to operate.
3. Guarded	Avoids accidental operation, used in start circuits.
4. Mushroom head	Distinguishes emergency stops, allows operation with gloved hands.
5. With locking attachment	Keeps operation under control of supervision or maintenance.
6. With extra long button	Distinguishes button from others.
7. With jogging attachment	Allows optional jogging without sealing circuit.
8. With ball lever operator	Reduces operator fatigue in specialized applications.
9. With protective boot	Protects button from ice, abrasive dust, or grease.
10. With rod operator	Emergency stop on pendant-type stations.
Illuminated Pushbuttons	
1. Resistor type 2. Transformer type	Saves space by combining button and light.
3. Guarded, resistor type 4. Guarded, transformer type	Avoids accidental operation.
5. Mushroom head, resistor type 6. Mushroom head, transformer type	Distinguishes button from others, allows operation with gloved hands.
Indicating Lights	
1. Full voltage	Signals circuit condition, 6 to 110/125-v ac or dc, least expensive type.
2. Full voltage, neon lamp	Provides high shock and vibration resistance with lamps at 110/125-v ac or dc.
3. Resistor type	Signals circuit condition, 230/250-v ac or dc.
4. Transformer type	Signals circuit condition; 110, 220, 440, and 550-v ac vibration and shock-resistant lamps.
5. Push-to-test, resistor type 6. Push-to-test, transformer type	Tests for burned out lamps in critical applications.
Selector Switches	
1. Two position 2. Three position 3. Four position	Provides maintained opening or closing of circuits, requires minimum space, provides reliability in corrosive atmospheres.
4. Three position, spring return to center 5. Three position, spring return from left 6. Three position, spring return from right	Keeps operation under operator's control ("dead man" control).
7. With potentiometer	Provides variable rather than digital voltage output.
8. Combination type, push-turn 9. Combination type, push-jog 10. Combination type, push-turn-push	Saves space while providing complex sequence.
11. With coin slot operator	Avoids accidental operation.
12. With cylinder lock and key 13. With provision for padlock	Keeps operation under control of supervision or maintenance.

Fig. 3—Miniature oiltight pushbuttons installed in the control panel for a spark erosion machine.

Table 2—Comparison of Typical Pushbutton Units

Feature	Standard Duty	Heavy Duty	Oiltight Heavy Duty	Miniature Oiltight
Space occupied (cu in.)	5½	9½	6¾	3½
Interchangeable units (within type only)	No	No	Yes	Yes
Flexible color coding	No	No	Yes	Yes
Nameplate fastening	Riveted	Riveted	Color ring	Color ring
Separate contact blocks	No	No	Yes	Yes
Terminal type	Screw	Screw	Saddle clamp	Snap-on
Maximum volts	600	600	600	150
Lamps required				
Ind. light, resistor or full voltage, 125 v	NE45	686	686	327
Ind. light, transformer, 125 v	None	55	55	328
Illuminated pushbutton, transformer, 125 v	None	None	12	12

Features of the four basic pushbutton types are compared in Table 2. Volt-ampere capacities for the different types can be obtained from the ratings in Table 3.

The last category—miniature oiltight—has been developed only recently. These smaller units alleviate the space problem created by the increasing number of switches and lights required for machine operation. Previously, some relief was provided by combining the standard-sized units, such as lights and buttons into illuminated pushbuttons.

Keys to the development of miniature oiltight units are use of high-strength, high-arc-resistant molded materials and provision of push-on, rather than screw type, terminals. Units are available in various colors and configurations as buttons, selector switches, and lights, Fig. 2. Several miniature units mounted in a control panel are shown in Fig. 3. To compare physical size, note the miniature pushbutton station in the upper left corner of Fig. 1.

Electrical Rating: Because the use of pushbuttons to operate magnetic motor starters represents a major industrial application, it is natural that pushbutton ratings are related to the electric current required by starter coils. Starter sizes have been standardized by NEMA (National Electrical Manufacturers Association), and a study was made to establish the current requirements of the magnets. Based on these values, recommended practice of the industry is to use standard-duty pushbutton units to control general-purpose magnetic starters which incorporate NEMA Size 4 (150 amp continuous) and smaller contactors. Starters using larger contactors, that is, NEMA Size 5 and up, are controlled by heavy-duty pushbuttons. Also, heavy duty buttons are generally

Table 3—Standard Electromagnet Loads for Pushbutton Stations*

Normal Potential† (volts)	Standard Duty Normal Current (amp)	Standard Duty Current Inrush (amp)	Heavy Duty Normal Current (amp)	Heavy Duty Current Inrush (amp)
110-125 ac‖	3.0	30	6.0	60
220-250 ac‖	1.5	15	3.0	30
440-480 ac‖	0.75	7.5	1.5	15
550-600 ac‖	0.6	6	1.2	12
115-125 dc	1.1		2.2	
230-250 dc	0.55		1.1	
550-600 dc	0.2		0.4	

*From Underwriters' Laboratories Inc. Standard UL 508.
†All tests to be made on the basis of the actual voltage rating.
‖Power factor, 35 per cent or less.

Table 4—Typical Markings for Station Nameplates

One Button	Two Button	Three Button
Standard-Duty Pushbutton Stations		
Start	Start-Stop	Forward-Reverse-Stop
Stop	Forward-Reverse	Open-Close-Stop
	Open-Close	Up-Down-Stop
	Up-Down	Raise-Lower-Stop*
	Raise-Lower*	Fast-Slow-Stop
Heavy-Duty Pushbutton Stations		
Start	Start-Stop	Start-Jog-Stop
Stop	Run-Stop	Run-Jog-Stop
Jog	Forward-Reverse	Forward-Reverse-Stop
Reset	Fast-Slow	Open-Close-Stop
Inch†	Open-Close	Fast-Slow-Stop
	Up-Down	Up-Down-Stop
	Raise-Lower*	Raise-Lower-Stop*
		Start-Inch-Stop†
		Run-Inch-Stop†

*Up-Down is preferred to Raise-Lower.
†Jog is preferred to Inch.

Table 5—Pushbutton Indicating Lights

Type	Resistance to Shock-Vibration	Light Output	Cost	Voltage
Full voltage 125-v lamp	Low	High	Low	125 v
Full voltage 6-v lamp	Better than 125-v lamp	High	Low	6 v
Resistor	High	Medium	Low	250 v
Transformer	High	Medium	High	110-550 v ac only
Neon lamp	High	Low	Low	125 v*

*May be higher if used with a resistor or transformer.

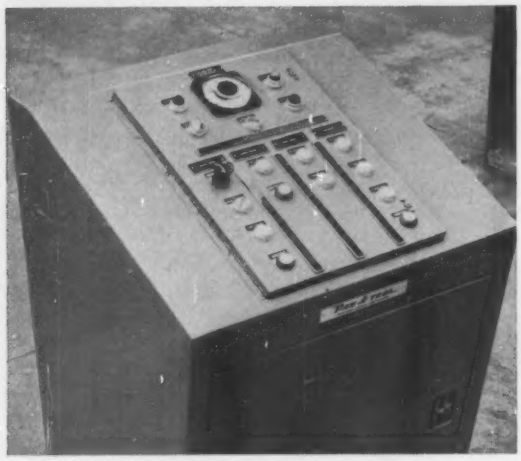


Fig. 4—Heavy-duty oiltight pushbutton units mounted in the control console for a cotton-baling machine.

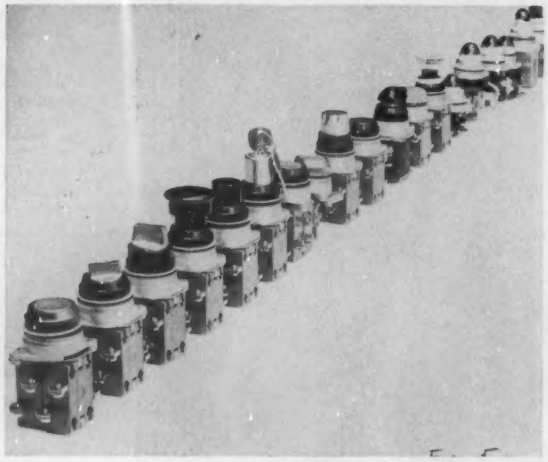


Fig. 5—Typical forms of heavy-duty oiltight pushbutton units.

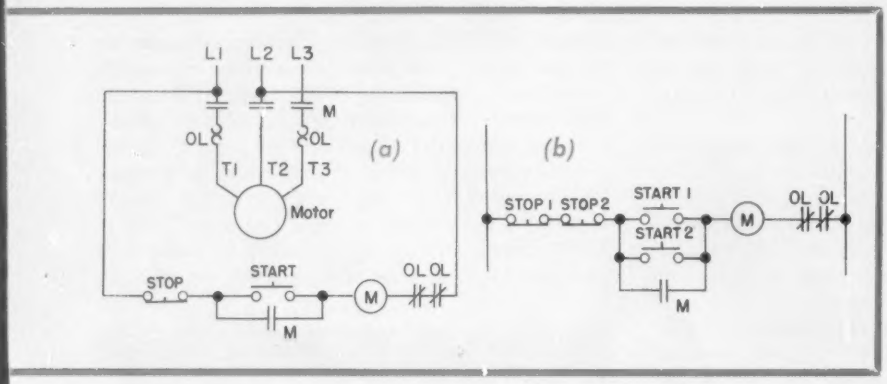


Fig. 6—Schematic diagrams for nonreversing motor control. Basic circuit, *a*, uses a single-station two-button control. A second station for remote operation is wired into the basic circuit, *b*.

used to control magnetic starters rated above 600 v.

Unit Identification

Quick identification of units is important in a multiunit station. A uniquely shaped button such as a mushroom head, functional nameplates, and a variety of colors provide identification. Typical nameplate markings for pushbutton stations are listed in Table 4.

Colors become associated in the operator's mind with the function provided by a particular unit. Black, red, yellow, green, white, and blue are colors that can be used singly or in combinations. Various standards specify the color to be used for certain functions. For example, buttons which function to stop a drive are colored red, and those which provide a *Return* function are colored yellow in accordance with NMTBA (National Machine Tool Builders Association) standards.

Station Arrangement

Unless special requirements dictate otherwise, pushbutton units are generally assembled in stations as follows:

1. *Stop* buttons are located below or to the right of their associated *start* buttons.
2. Indicating lights are located above the buttons with which they are associated.
3. In the case of a two-light station, one light is located at the top and the other at the bottom of the station.
4. Pushbuttons are grouped above selector switches.
5. The emergency *stop* button is at the bottom of the station and is a red mushroom-head button.
6. The highest-speed button in multispeed stations is located at the top.

On many machines used throughout industry, particularly those used for metalworking, accepted practice is to mount pushbuttons and lights either individually as a part of a control station or console, on the front or side of a control panel, or in a suitable recess in the frame of the machine. Oiltight units are used in the console shown in Fig. 4. These units are rated as heavy-duty pushbuttons and are available in several forms, Fig. 5. As building blocks, they provide great flexibility in both mounting and wiring arrangements.

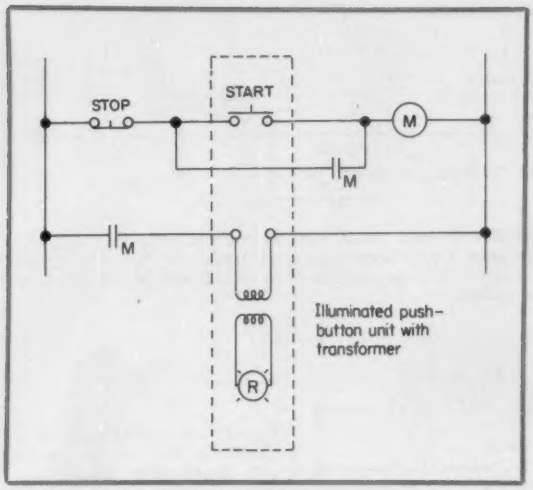


Fig. 7—Transformer-powered lamp type of illuminated pushbutton in nonreversing motor-control circuit.

DEFINITIONS

A pushbutton switch (pushbutton) is a master switch, usually mounted behind an opening in a cover or panel, and having an operating plunger or button extending forward in the opening. Operation of the switch is normally obtained by pressure of the finger against the end of the button.

A pushbutton station is a unit assembly of one or more externally operable pushbutton switches, sometimes including other pilot devices such as indicating lights or selector switches, in a suitable enclosure.

The control circuit of a control apparatus or system is the circuit which carries the electric signals directing the performance of the controller but does not carry the main power circuit.

The pilot circuit of a control apparatus or system is that portion of its control circuit which carries the controlling signal from the master switch to the controller.

Undervoltage protection is the effect of a device, operative on the reduction or failure of voltage, to cause and maintain the interruption of power to the main circuit. Note: The principal objective of this device is to prevent automatic restarting of the equipment. Standard undervoltage or low-voltage protection devices are not designed to become effective at any specific degree of voltage reduction.

—From American Standards Association publication, ASA C42.25-1957.

Pilot Circuit Applications

In the circuits which follow, note that:

1. All pushbutton units are connected to one side of the line to keep all their contacts at the same potential.
2. Mechanical interlocking between contacts is indicated by dotted lines.
3. Physical relationships are disregarded.
4. Symbols conform to those listed in NEMA, NMTBA, and JIC standards.

Momentary-Contact Units: Fig. 6 shows in elementary form the basic connections of a nonreversing, full-voltage, across-the-line magnetic starter. Starter operation is controlled by a pushbutton station having two momentary-contact buttons. In both circuits of Fig. 6 a starter contact wired in parallel with the *start* button provides undervoltage protection (see *Definitions*). At some decreased value of voltage the starter magnet will become sufficiently weakened to permit the holding contact to open. Thus, even though full voltage is later restored, power will not be applied to the drive until the momentary-contact *start* button is depressed. Such protection is an accepted practice throughout indus-

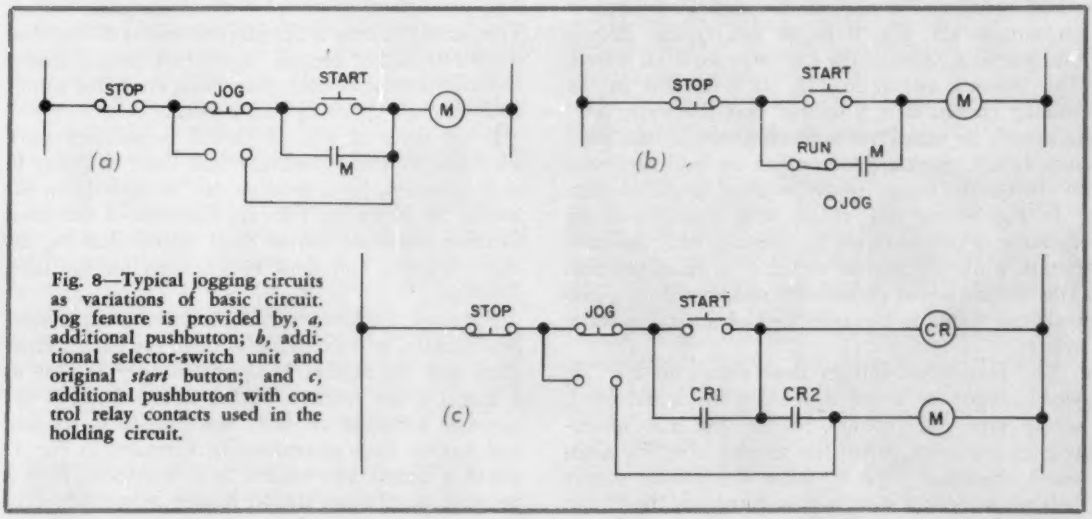


Fig. 8—Typical jogging circuits as variations of basic circuit. Jog feature is provided by, *a*, additional pushbutton; *b*, additional selector-switch unit and original *start* button; and *c*, additional pushbutton with control relay contacts used in the holding circuit.

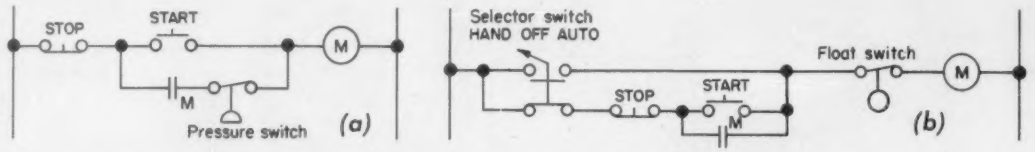


Fig. 9—Circuits combining pushbutton units and pilot devices. In *a*, *start* button can override the pressure switch to check the starter or raise liquid level above set limit. In *b*, selector switch in *hand* position does not permit *start* button to override float switch and in *auto* position does not provide undervoltage protection.

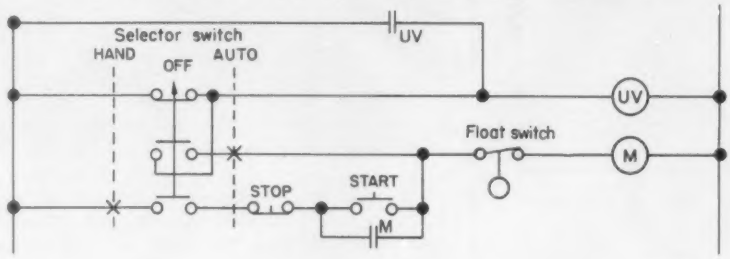


Fig. 10 — Modification of circuit in Fig. 9*b* to provide undervoltage protection with UV relay and contacts.

try and represents the most popular application of this type of pushbutton station.

There are, of course, certain applications where it is desirable to have equipment restart automatically following a reduction or loss of voltage. In such cases, the circuitry and devices are said to provide undervoltage release.

An illuminated pushbutton can be substituted for the *start* button in the basic circuit, Fig. 7. Visual evidence of an on or off condition is often convenient for drives in noisy, obscured, or remote locations.

Many modifications of the basic circuit of Fig. 6 are possible. A jogging function is provided by the typical circuits in Fig. 8 to position loads in material handling or to facilitate machine-tool setup. In these arrangements an additional pushbutton unit is used—either a button or a selector switch.

If a drive starter is to be controlled by the maintained contact of a pilot device such as a float or pressure switch, Fig. 9 shows two typical circuits that permit a check of the starter to see if all is well. The pressure switch in Fig. 9*a* is located in the holding circuit. If it is desired that the water level in a tank be raised above the limit set by the pressure switch, the *start* button can be held depressed to operate the pump for the required length of time.

In Fig. 9*b* the float switch is so located that the operator cannot override its opening with the *start* button while the selector switch is in *hand* position. This feature would prevent the addition of too much make-up water to the cold well of a cooling-water system.

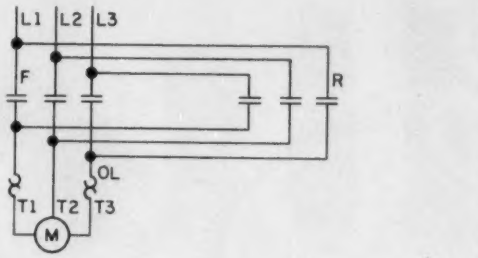
The maintained-contact float switch in Fig. 9*b*, which opens or closes depending on liquid level, would give undervoltage release, but not undervoltage protection, when the selector is set for automatic operation. That is, when the voltage supply fails or is reduced and is then corrected, the circuit will automatically become operative.

If undervoltage protection is desired from a safety standpoint, an undervoltage relay can be added to the circuit as shown in Fig. 10. Here, voltage failure with the selector in the automatic position requires switching to *off* and then back to *auto* before operation can be resumed. The undervoltage relay is energized in the *off* position. The *UV* (undervoltage) contacts then keep the relay energized and also energize the starter circuit when the selector is turned to *auto*.

Standard circuitry for a drive of the reversing type, such as a motor which operates a valve, is shown in Fig. 11 for a reversing starter and a stop-pushbutton station. Note that the back contacts of the *close* button are wired in series with the pick-up circuit controlled by the *open* button. The converse is true for the back contacts of the *open* button which supply the feed to the pick-up of the *close* button. This wiring scheme is an effective means of electrical cross-interlocking because it prevents both the *open* and *close* contactor coils from being energized simultaneously by depressing both buttons.

If the drive of Fig. 11 should be stopped automatically at some predetermined limit of travel in each direction, limit switches can be inserted in the wiring as shown in Fig. 12. Contacts of the limit switches are identified as *limit switch close* for the close direction and *limit switch open* for the open direction.

For some applications, such as floor-operated overhead cranes, it is desirable to have the circuit energized and the motion in operation only so long as a man's finger holds a button down. Thus, if the operator stumbles or falls, the button is released and motion stops automatically. Circuitry in Fig. 13 shows a simple two-motion hoist controlled from a pendant pushbutton station having momentary-type



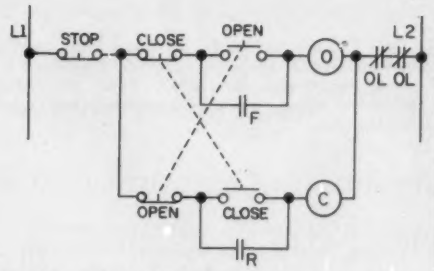


Fig. 11—Typical circuit for a reversing motor starter with electrical interlocking of *forward-reverse*, or *open-close*, pushbuttons.

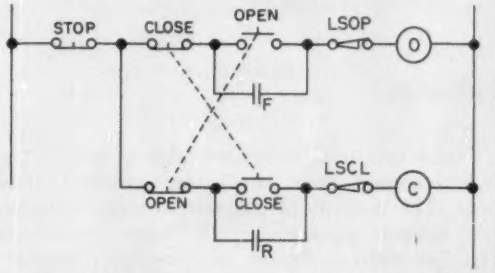


Fig. 12—Insertion of limit switches in circuit of Fig. 11 to stop travel of motor-operated valve at specified positions.

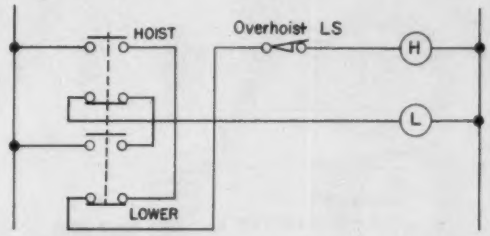


Fig. 13—Wiring of momentary-contact pushbuttons in hoist circuit opens circuit for safety if both buttons are depressed simultaneously.

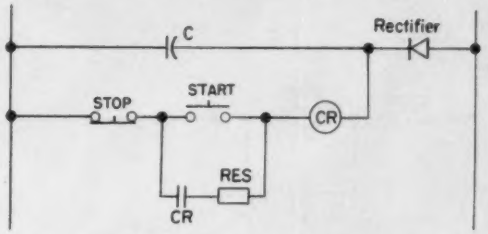


Fig. 14—Circuit of a special pushbutton unit for time-relay drop-out feature.

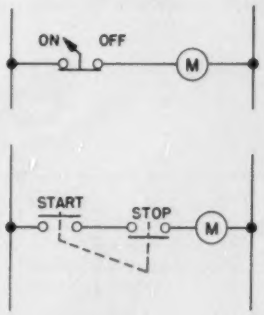


Fig. 15 — Circuit diagrams for maintained-contact selector switch and two-position maintained - contact pushbutton.

units. As a necessary safety feature, note that the contacts of an overhoist limit switch are placed in series with the coil of the hoist contactor.

A spring-return selector switch is also used in applications which must remain under the control of the operator, as when the selector by-passes limit switches. Other uses are to save space by performing the function of two or three pushbuttons and to allow safe hand operation of, for example, molding presses during set-up.

Special pushbutton designs can provide time-delay functions in a number of ways. Fig. 14, for instance, uses a resistance-capacitance circuit for a time-delay drop-out. If a momentary interruption of power were to occur in a continuous textile or chemical process, the operation would restart when voltage was restored. However, if power remained off longer than some predetermined time, say two seconds, then normal undervoltage protection would prevail.

Maintained-Contact Units: Certain types of circuits, after they are once set up, should remain unchanged even in the event of a power failure. In such cases, either maintained-contact selector switches or, for simple applications, two-position maintained-contact pushbuttons can be used, Fig. 15. In general, selector switches are preferred over maintained-contact pushbuttons.

Indicator Circuit Applications

Circuitry and pushbutton applications discussed so far have all been for the pilot type of circuit. While pushbuttons give long life handling 6-w pilot lights and small arc-suppression capacitors and coils, they are not designed or approved by Underwriters' Laboratories Inc. for use in power circuits to handle motors, lamp loads, large capacitors, or similar types of equipment directly. For example, an incandescent lamp load has an initial cold-make current twenty times its normal operating requirements. A pilot device designed for service in the basic circuit of Fig. 6 might have its silver contacts welded together when closing on such a high initial current.

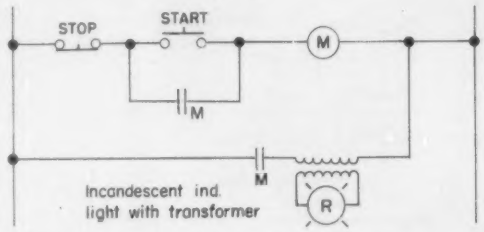


Fig. 16—Circuit for a transformer-type incandescent indicating light.

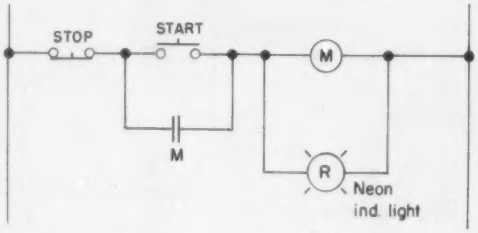


Fig. 17—Permissible circuit connection for neon indicating light.

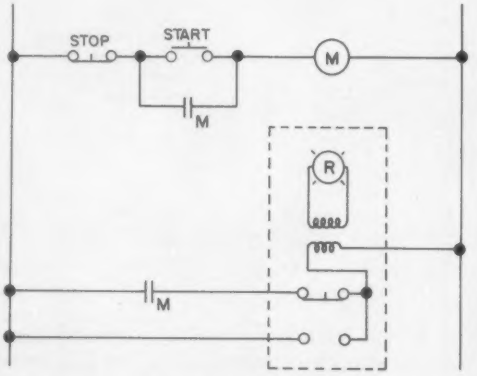


Fig. 18—Wiring of a push-to-test unit with transformer-powered indicating light.

It is generally not desirable to connect an incandescent indicating light directly in parallel with the coil of a contactor. Fig. 16 shows a preferable arrangement which gives better results. A neon lamp, however, may be connected directly across the coil, Fig. 17. A comparison of various types of indicating lights is given in Table 5.

"Push-to-test" units were designed to cope with the fact that lamps in indicating lights do burn out. Thus, it is important to determine whether an unlit indicating light signals the condition of the circuit as it ought to do or whether it signifies that the bulb is burned out. A test circuit provided in the unit, Fig. 18, allows the operator to make this determination in critical applications.

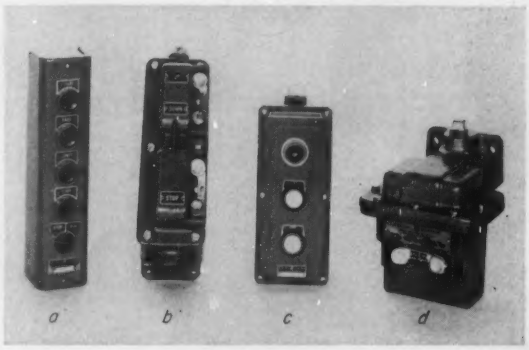


Fig. 19—Typical enclosures for heavy-duty pushbutton stations: *a*, NEMA Type 1, general purpose; *b*, NEMA Type 4, watertight; *c*, NEMA Type 12, industrial-use; *d*, NEMA Type 7, gas explosionproof, and Type 9, dust explosionproof.

Enclosures

Pushbutton stations are available in several types of enclosures to meet varying environmental conditions. The majority of pushbutton stations incorporate general purpose NEMA Type 1 enclosures, Fig. 19*a*. Such enclosures are intended primarily to prevent accidental contact with live parts and are suitable for general-purpose applications in industries where they are not exposed to unusually severe conditions.

For use out-of-doors, subject to corrosion, rain, snow, ice, and on occasion being washed down (as on paper mill drives), watertight or NEMA Type 4 enclosures are recommended, Fig. 19*b*. In cases of severe corrosion or icing, the enclosure design allows the operating lever to be broken free without damage to the station.

NEMA Type 12 industrial-use enclosures, Fig. 19*c*, are designed to keep out dust, lint, and fibers and flyings as might be encountered in textile installations. They also provide protection from the oil seepage and coolants common to metal-working machinery. Use in such environments is the main reason why oiltight heavy-duty units were developed.

Where hazardous and explosive atmospheric conditions exist, NEMA Type 7, gas explosionproof, and NEMA Type 9, dust explosionproof, enclosures are available for pushbuttons, Fig. 19*d*. Petroleum-cracking plants, gasoline filling stations, sewage-disposal plants, and gas-preparation plants are typical installations where explosionproof pushbutton stations should be used.

Beam Vibrations

- *Selecting beam dimensions to avoid undesirable resonance*
- *Determining fundamental frequencies of given beam configurations*

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MECHANICAL vibrations may contribute to premature failure or malfunction of equipment if they are overlooked in the design stage. Resonance can cause failure of a support structure itself, or can induce extremely high accelerations into the component or system which the structure supports. Both situations are undesirable. Vibration failures of this nature can be prevented in several ways:

1. Design the structure so that resonance will not occur under the highest actual vibration frequency that may be encountered.
2. Design the structure so that its natural frequency is extremely low with respect to the lowest actual vibration frequency.
3. Provide a damping system that will dissipate the resonant energy and limit the amplitude.

Of these methods, the first two are the simplest and most straightforward, provided that the nature of the vibration environment is known or can be estimated.

As an aid in design, this article presents a nomogram, Fig. 1, that relates the fundamental parameters of an unloaded rectangular cross-section beam with the natural (or resonant) frequency. The nomogram was derived from the principles of vibration of elastic bodies.[1-3] Such a chart allows one to conveniently manipulate the design variables to achieve any desirable result.

The basic frequency equation for lateral beam vibrations is

$$\omega_n = \frac{K}{L^2}\sqrt{\frac{gEI}{w}}$$

where mode factor K is determined by the nature of the beam-end restraints. Factor K has been determined for a number of support conditions and is

[1]References are tabulated at end of article.

Nomenclature

E	= Modulus of elasticity, psi
f_n	= Natural frequency, cps
	= $\omega_n/2\pi$
g	= Acceleration due to gravity, in./sec^2
h	= Beam height, in.
I	= Beam area moment of inertia, in.^{4}
K	= Mode factor
L	= Horizontal beam length between supports, in.
w	= Beam weight per unit length, lb/in.
ρ	= Beam density, lb/cu in.
ω_n	= Natural circular frequency, rad/sec

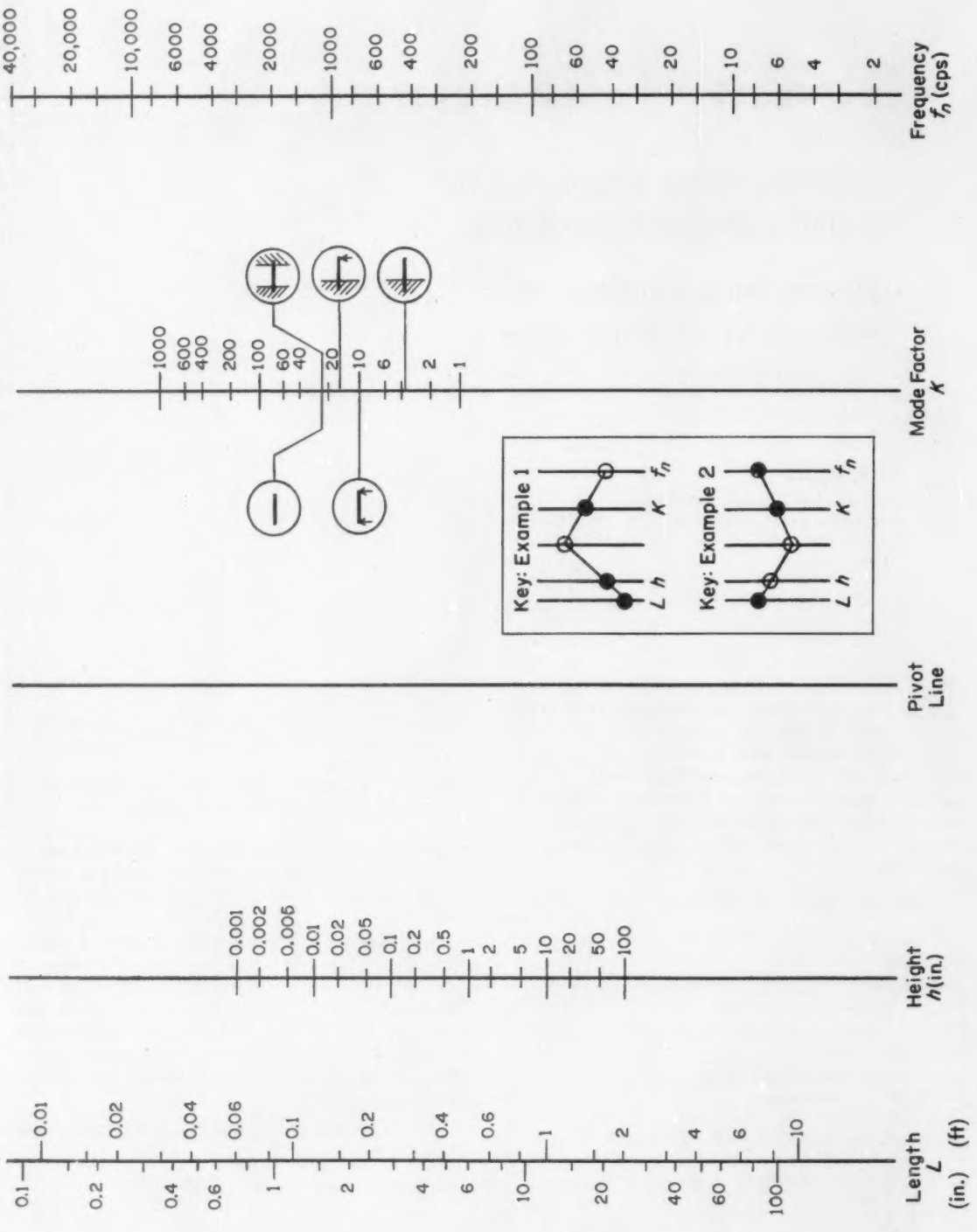

Fig. 1—Nomogram for calculating natural frequency of unloaded rectangular cross-section beams from beam dimensions and support conditions.

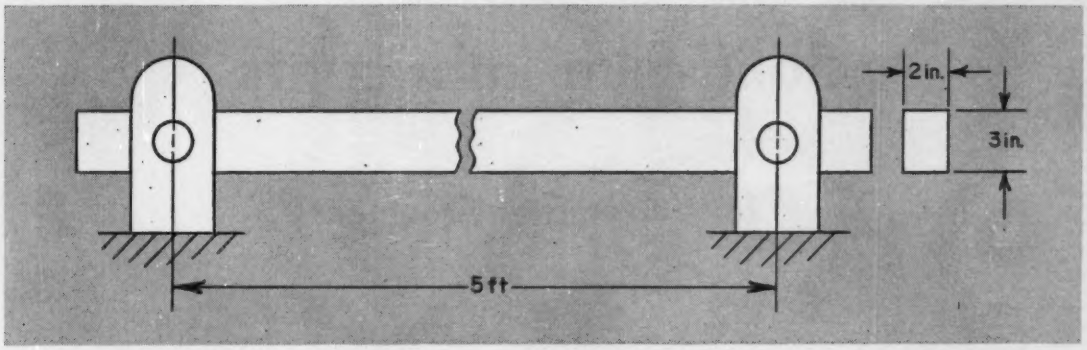

Fig. 2—Typical example: Hinged magnesium beam.

given in Table 1 for the first three bending modes. For a uniform, rectangular cross-section beam,

$$\omega_n = 2\pi f_n = \frac{Kh}{L^2}\sqrt{\frac{gE}{12\rho}}$$

The ratio of the modulus of elasticity to the density is practically the same for aluminum, magnesium, and steel. That is, $E/\rho = 103 \times 10^6$, within a narrow range, for all three materials. Therefore, one frequency relationship suffices for them.

Finally,

$$f_n = 9180\,\frac{hK}{L_2}$$

The nomogram in Fig. 1, which represents this equation, may be used for aluminum, magnesium, and steel, or with any material having the same modulus to density ratio.

The nomogram gives solutions for beams that are unloaded except for their own weight. In actual applications where there may be additional mass on the beam, a lower natural frequency than that determined by the nomogram can be expected.

Fundamental mode factors K have been designated on the nomogram for convenience. If the second or third bending mode frequencies are sought, the values of K listed in Table 1 should be used.

Table 1—Mode Factors

Beam Support Condition	Fundamental Mode, K_1	Second Mode, K_2	Third Mode, K_3
Simply supported (hinged)	9.87	39.50	88.90
Cantilevered	3.52	22.00	61.70
Restrained	15.40	50.00	104.00
Double cantilevered	22.40	61.70	121.00
Free-free	22.40	61.70	121.00
Hinged-free	0	15.40	50.00

Example 1: Find the fundamental natural frequency in the vertical direction of the hinged magnesium beam shown in Fig. 2.

SOLUTION: Starting at 5 ft on the length scale of the nomogram, pass a straight line from this point through the 3-in. mark on the height scale. Through the intersection of this line and the pivot line, draw another line passing through the simply supported beam condition on the K scale to intersect the f_n scale. The natural frequency is thus 76 cps.

Example 2: A cantilevered steel spring is desired which has a mounted free length of 1 in. and which will exhibit no resonance within the frequency range from zero to 2000 cps. What will be the minimum spring thickness?

SOLUTION: Draw a line through 2000 cps on the frequency scale and the point on the mode-factor scale designated by the cantilevered-beam condition. Extend this line to intersect the pivot line, and connect this point with a line passing through 1 in. on the length scale. The intersection of this line with the height scale defines the minimum thickness of 0.062 in.

In the actual design of such a spring, where usually a specific spring rate also must be incorporated, the width of the beam must be adjusted to obtain the correct stiffness.

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1. W. T. Thomson—*Mechanical Vibrations*, Prentice Hall, Englewood Cliffs, N. J., 1953.
2. J. P. Den Hartog—*Mechanical Vibrations*, McGraw-Hill, New York, N. Y., 1956.
3. S. Timoshenko and D. H. Young—*Vibration Problems in Engineering*, D. Van Nostrand Co., New York, N. Y., 1955.

Solid-Film Lubricants

for extreme environments

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THE term "solid-film lubricants" designates a series of lubricating materials consisting of a friction - and - wear - reducing pigment, such as graphite or molybdenum disulphide, bonded to the bearing surface with some type of adhesive. Another term, "dry-film lubricants," refers to materials which react chemically with the metal surface or are plated on to provide wear resistance. Solid films are generally considered for use in extreme environments such as extremely high temperatures, temperatures in the cryogenic region, areas of high-intensity nuclear radiation, and hard vacuum. However, these lubricants also work in less severe applications.

In addition to their stability in extreme environmental conditions, solid films have one particular attribute which makes them attractive for any application. This is the property or concept of lubrication for the life of a system, with no external lubrication network. Thus applied, solid films save weight and money by eliminating the complex lubrication system and/or maintenance associated with other materials.

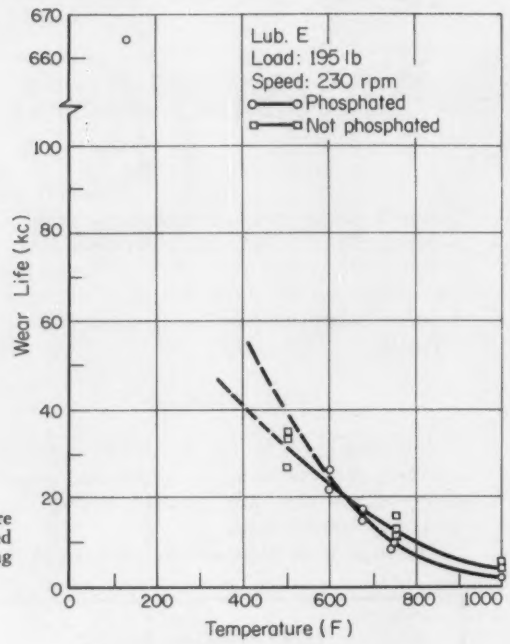


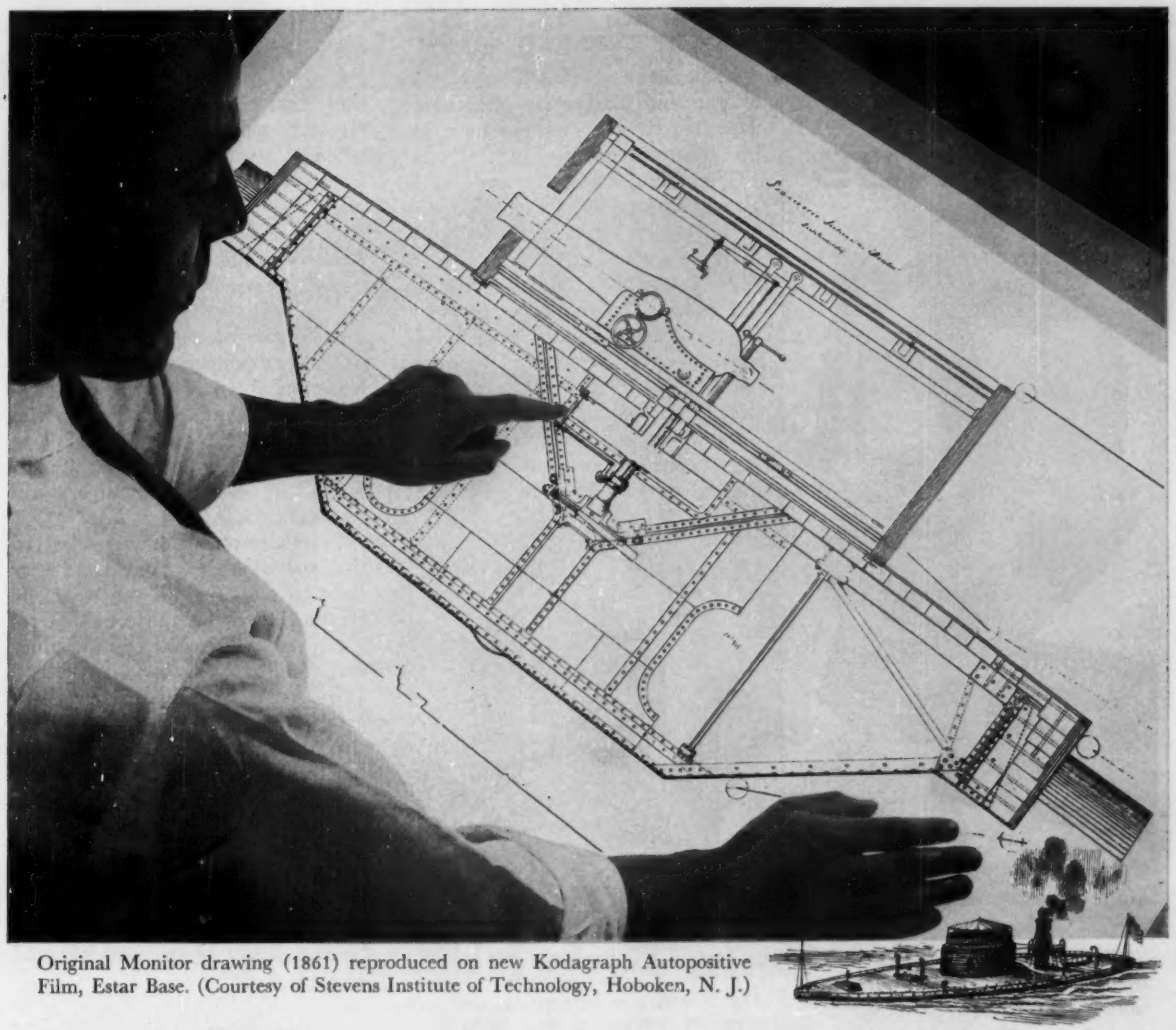
Fig. 1—Effect of temperature on wear life of phosphated and nonphosphated bearing surfaces.

Present Capabilities: Dry-film lubricants on the market today are composed of a pigment or friction-reducing mitigant, a binder which is in most cases an organic adhesive, and a thinning solvent to give the proper consistency for spray application or dip coating. This mixture is applied to a metallic bearing surface which has been subjected to some form of pretreatment to increase the adhesive bond between the metal and the film. The relative merits of one film over another rest in the differences in the pigments selected, the binders used, the pigment-to-binder ratio, and the compatibility of pigments and binders in a cured composition.

In general, these films provide satisfactory lubrication from room temperature to 400 to 500 F for slowly sliding bearings under heavy loads and high-speed parts under light loads. This type film is an outstanding antiseize material.

Choice and controlled application of the proper pretreatment on the substrate metal has a tremendous influence on performance. Commonly used surface treatments for ferrous metals include iron and manganese phosphating, vapor blasting, and grit blasting.

Phosphate treatment has the largest influence in increasing wear life. Unfortunately, this pretreatment is limited to metallic substrates of iron and steel. The phosphate pretreatment creates a non-



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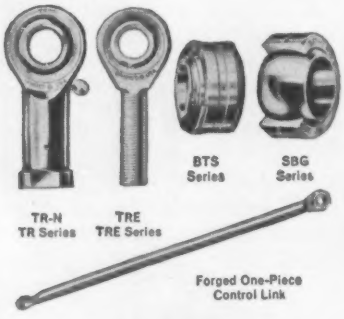

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metallic coating consisting chiefly of iron and manganese phosphates deposited in a crystalline form on the substrate metal.

The phosphating procedure is also limited in its method of application. Temperature of the bath must be controlled within 5 to 6 deg of the determined optimum temperature. Optimum performance of films is limited to 600 F if they have a phosphate pretreatment, Fig. 1. Dotted portions of the curves in Fig. 1 indicate the trend to be expected with decreasing temperature. Since phosphating is unsatisfactory above 600 F, surfaces must be worked mechanically, as with grit or vapor blast.

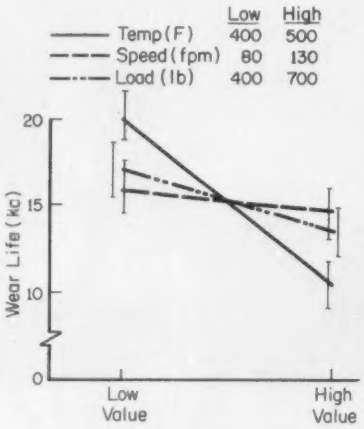

Fig. 2—Effect of temperature, load, and speed on wear life of solid films.

Currently, the performance capabilities of dry-film lubricants are being investigated at temperatures from the cryogenic level to 1000 F or better and in such environments as nuclear radiation and hard vacuum. Performance parameters are environmental temperature, bearing load, substrate hardness, film thickness, relative linear surface speed, lubricant material, film binder, lubricant-to-binder ratio, type of motion (unidirectional or oscillatory), and the geometry of the rub-shoe surface. Parameters having predominant effect on wear life are temperature and load. Observe in Fig. 2 the change in wear life when going from low temperature at high loads and high speeds to high temperatures at low loads and low speeds.

Another recent program was the evaluation of solid lubricants at extremely low temperatures. Results show that an 85 to 95 per cent decrease in wear life can be expected when the environment changes from room temperature to the temperature of liquid nitrogen. No particular lubricant shows favorable wear life under these conditions. However, NASA has shown that polytetrafluorethylene films provide exceptionally good lubrication at low temperatures under light loads and relatively high sliding velocities. Apparently the properties of PTFE which cause it to fail at higher loads do not affect its lubricity at cryogenic temperatures and light loads.

In other studies, it was observed that radiation, in general, had very little effect either on the wear life of the film or on the corrosion resistance, fluid resistance, and thermal stability.

In general, films which have good corrosion resistance, fluid resistance, and thermal stability are not seriously changed by gamma or neutron exposure. The same is true for wear life. In fact, in some cases, radiation seemed to improve the performance. In tests which yielded these results, the radiation could change completely the physical properties of the best oils and greases.

Future Films: Although solid films have been employed mainly in sliding-type application, rolling applications will increase. There are requests for solid films to be used at 1200 F in small accessory bearings operating at 15,000 rpm under light loads.

NASA is working on materials usable to 1000 F. The most promising of their films consists of PbO bonded to the surface with silicate of soda.

Midwest Research Institute has conducted a survey of over 22,000 compounds and has found approximately 1500 materials with melting points over 1000 F. This survey was then used for selection of about 60 solids as possible pigments. Tests showed inconsistent low friction at all temperature levels. The most promising film developed to date by MRI is a PbS pigment bonded with B_2O_3.

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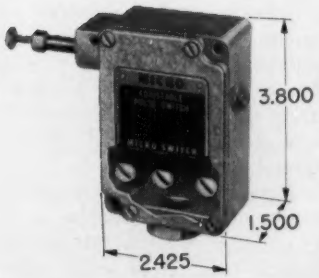

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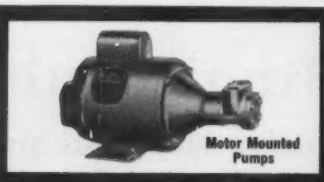
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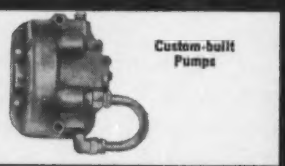
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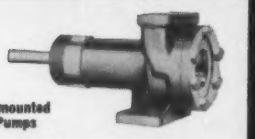
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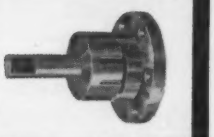
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Films—Lubricants for Extreme Environments," presented at the Petroleum Mechanical Engineering Conference, New Orleans, Sept., 1960, 11 *pp.*

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Stanley L. Levine, Litton Industries

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WESCON Paper, "Introduction to Teaching Machines," presented in Part 4, Session 24, IRE Western Electronic Show and Convention, Los Angeles, Aug., 1960, 4 *pp.*

Proposed Symbology For Digital Systems

Prepared by an ad hoc group of the AIEE Computing Devices Committee

An urgently needed reference on suggested symbols for design and maintenance requirements of digital systems. Topics are presented in three sections: Algebraic symbols, graphical symbols, and printed graphical symbols.

Algebraic symbols designate the relations of logical variables in binary notation for combinational and sequential logic. Appropriate indexing is provided for canonical forms (minterms, maxterms), general logical expressions, and time-dependent expressions. All symbols are restricted to characters which are available on conventional typewriters and printer keyboards.

Drafting symbols are suggested for manually prepared logical diagrams with provision for complete

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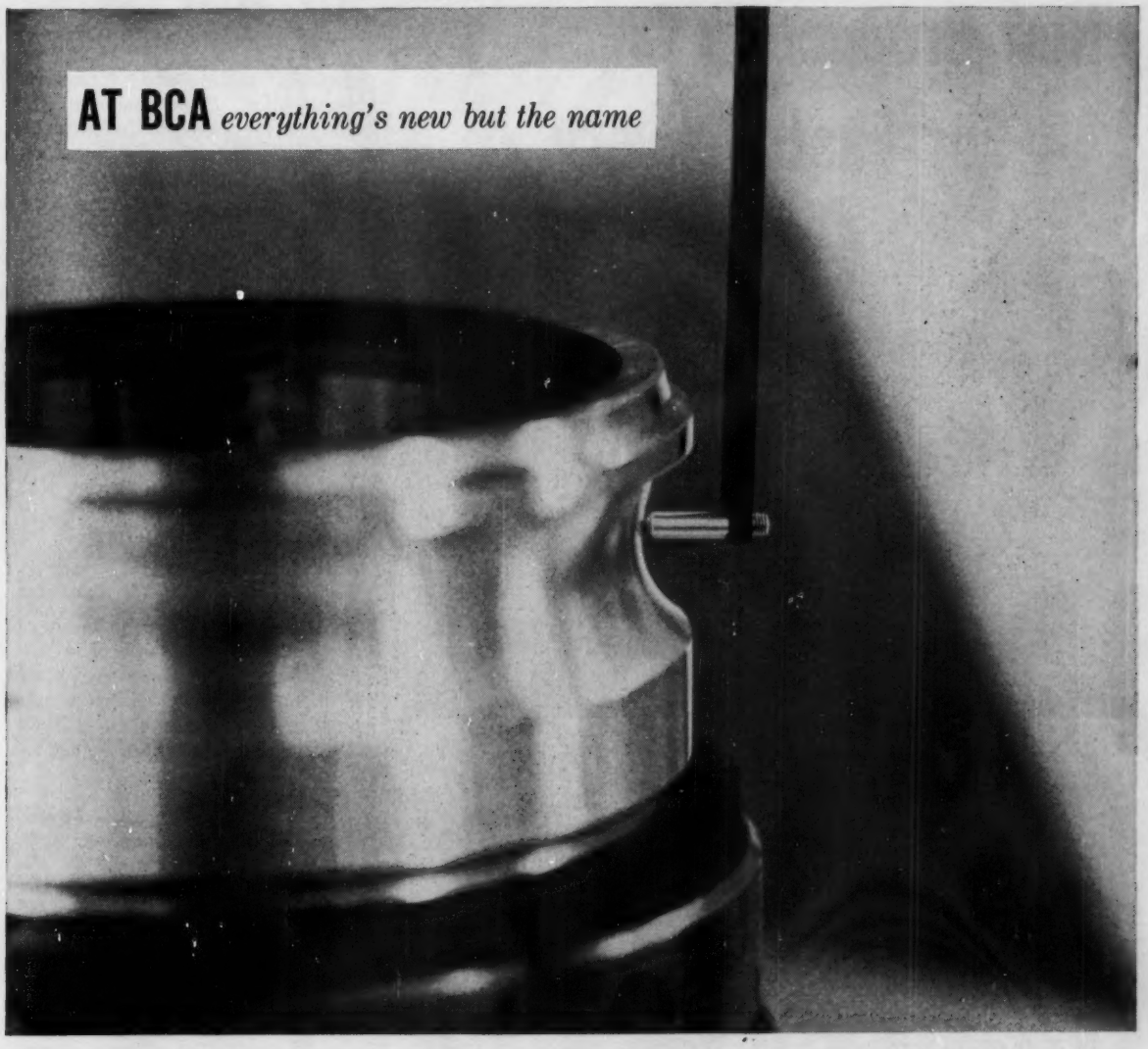

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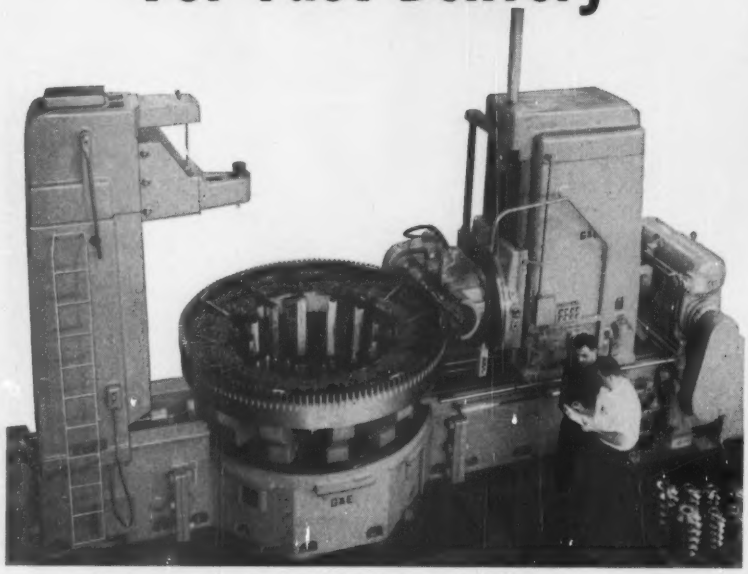

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AIEE Paper No. 60-1224, "Proposed Symbology for Digital Systems," presented at the AIEE Fall General Meeting, Chicago, Oct., 1960, 18 pp.

Dictionary of Switching Theory Terms

Prepared by an ad hoc group of the AIEE Computing Devices Committee

Preliminary draft of a dictionary of relevant terms in the field of switching theory. To illustrate the nature of the proposed work, some words have definitions and some do not. The compilers have been guided by a few simple principles:

1. As it is clearly necessary to fix arbitrary boundaries to the scope of the dictionary, it has been decided that terms should be limited to those current in the theory of switching circuits and should not include terms having principally to do with the engineering of circuits.
2. The compiliers have no desire to dictate usage, but wish rather to survey usage. The profusion of synonymous terms evident in the current literature does indeed seem extensive, but it is felt that a thorough survey must precede any sensible effort to guide usage. The compilers further doubt that any effort at guidance can be successful, even after a survey has been completed.
3. Despite reluctance to judge the relative merits of synonyms, and for the sake of brevity, each idea is defined only once. Cross-references to that definition are given for all synonyms. This lends the unavoidable appearance that the term against which the definition is given *in extenso* is in some way to be preferred over its synonyms. No such appearance is intended.
4. The principal use of the resulting work is expected to be that of any dictionary—a reference of the meanings of words.

It is planned that the list of terms and definitions shall be published

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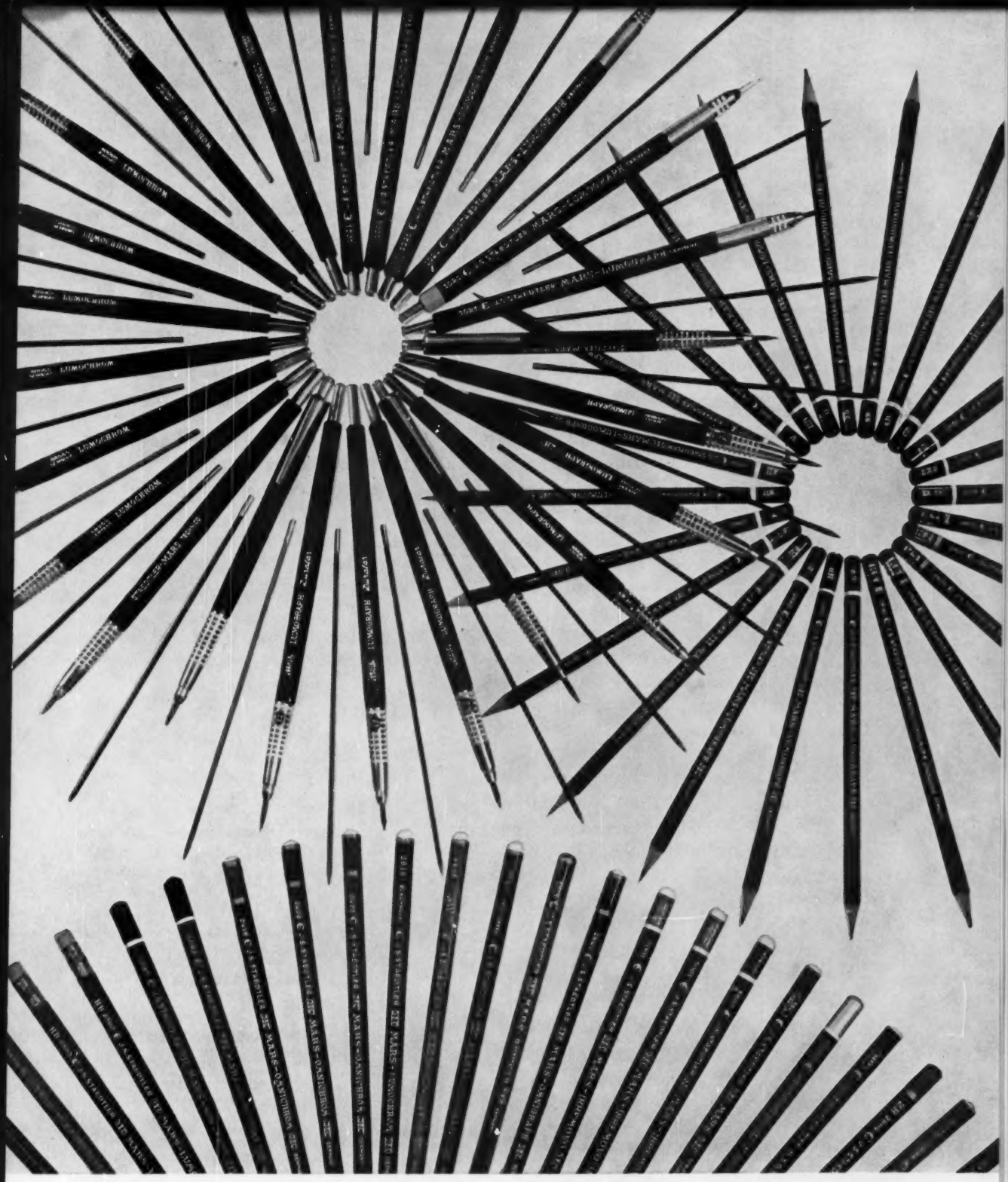
Circle 520 on Page 19→



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NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH, N. H.

From the office of
ARTHUR N. DANIELS,
President

RE: Instrument Ball Bearings

Gentlemen:

Most of us didn't learn much about anti-friction bearings in Engineering School. In my own case, we learned the difference between ball, roller and needle bearings, and that's about all. Literature on the subject is sparse; the variety of types, sizes and extra features is vast. All have their limitations, advantages and disadvantages.

This is a plea, then, for taking a Bearing Engineer into consultation before your layouts or designs are frozen. He is a professional and his services are free. We have ten of them, at your disposal, in addition to a staff of specialists at our home office.

True, they have an axe to grind: to sell you instrument ball bearings. But none of them wants to make recommendations that will fail to meet requirements, or to propose a marginal solution. Ethics of course prohibit their revealing your plans to others. Sometimes they will say "No," or "Maybe," or "Tests must be run." We've not accumulated all the answers yet, doubtless never will. Then, for confirmation, a competitor can be called in. We have a few who know a little about it. And, as sometimes happens among professionals, he may dissent, leaving the judgment up to you.

We believe too that our own new 150-page Design Manual is the most comprehensive treatise on instrument ball bearings published. We shall be glad to send you a registered copy by return mail.

Sincerely,

A. N. Daniels
President

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periodically and revised continuously.

AIEE Paper No. CP 60-1225, " A Dictionary of Switching Theory Terms; Preliminary Draft," presented at the AIEE Fall General Meeting, Chicago, Oct., 1960, 25 pp.

mechanical

Analyses of Shock and Vibration Motions

Dr. Irwin Vigness, U. S. Naval Research Laboratory

Techniques for analyses of shock and vibration motions which are of most value to the shock and vibration specialist and to the design engineer. Three classes of shock and vibration motions are considered: Periodic vibrations, non-periodic vibrations of relatively long duration, and transients of relatively short duration. Each of these classes are analyzed by methods which most simply describe their characteristics.

An analysis may express the motion that is equivalent in important details to the motion under study, or it may describe the effects of the motion on standard, simple systems. Because of different factors involved in airborne as opposed to structure - borne vibrations, the methods of analyses of air pressure variations and structural vibrations are somewhat different.

ISA Paper No. 4-NY-60, "Analyses of Shock and Vibration Motions," presented at the Fall Instrument-Automation Conference and Exhibit, New York, N. Y., Sept., 1960, 12 pp.

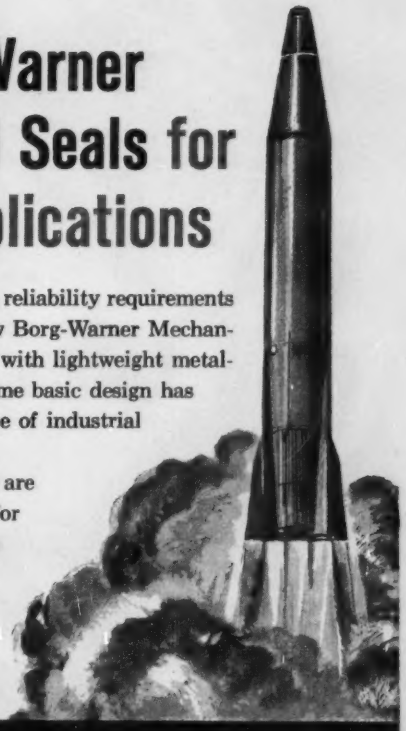
Positive-Displacement Engines Vs. Turbines in Extreme Cold

Homer J. Wood, H. J. Wood and Associates, and Normand E. Morgan, Vickers Inc.

Review, appraisal, and updating of reciprocating steam-engine technology to derive new expansion engines for space auxiliary power in competition with turbines. Even "conventional" steam-engine performance looks good, when proper parameters are used, for comparison with the latest in turbine technology.

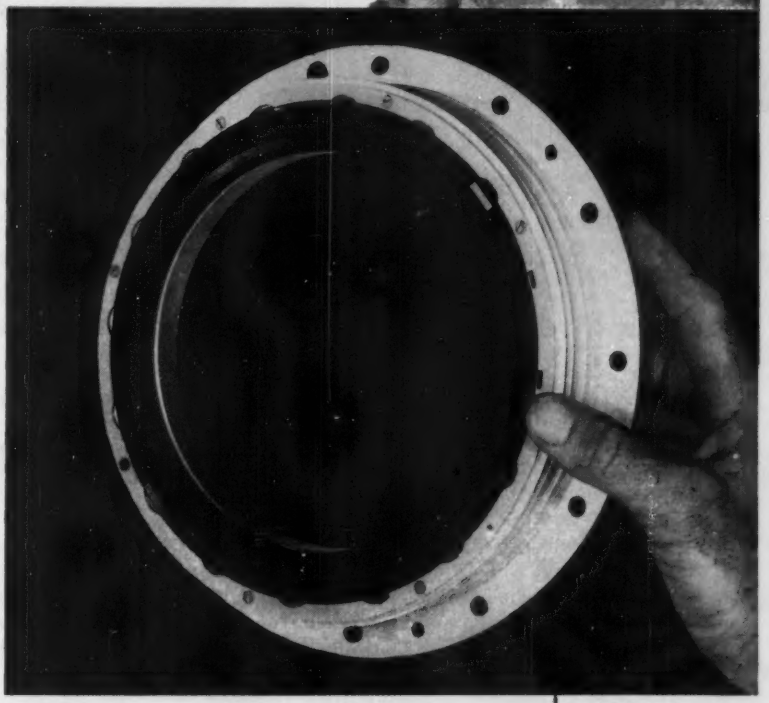
The most expressive single parameter is adiabatic shaft efficiency for

Now...Borg-Warner Mechanical Seals for Airborne Applications



Developed especially to meet the reliability requirements of airborne components, this new Borg-Warner Mechanical Seal combines compact size with lightweight metallurgy. Entirely new—yet this same basic design has been proved in almost every type of industrial and military shaft sealing job.

Borg-Warner Mechanical Seals are used daily under high pressures, for high or ultra-low temperatures, to seal toxic, corrosive and volatile liquids, and even for radioactive fluids. *Whatever your needs for sealing a rotating shaft, a B-W Mechanical Seal can answer it.*



Typical operating conditions — rocket engine fuel pump at 7450 rpm and 250°F.

Borg-Warner®

Mechanical Seals

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DIVISION OF BORG-WARNER CORPORATION

P.O. Box 2017, Terminal Annex, Los Angeles 54, California

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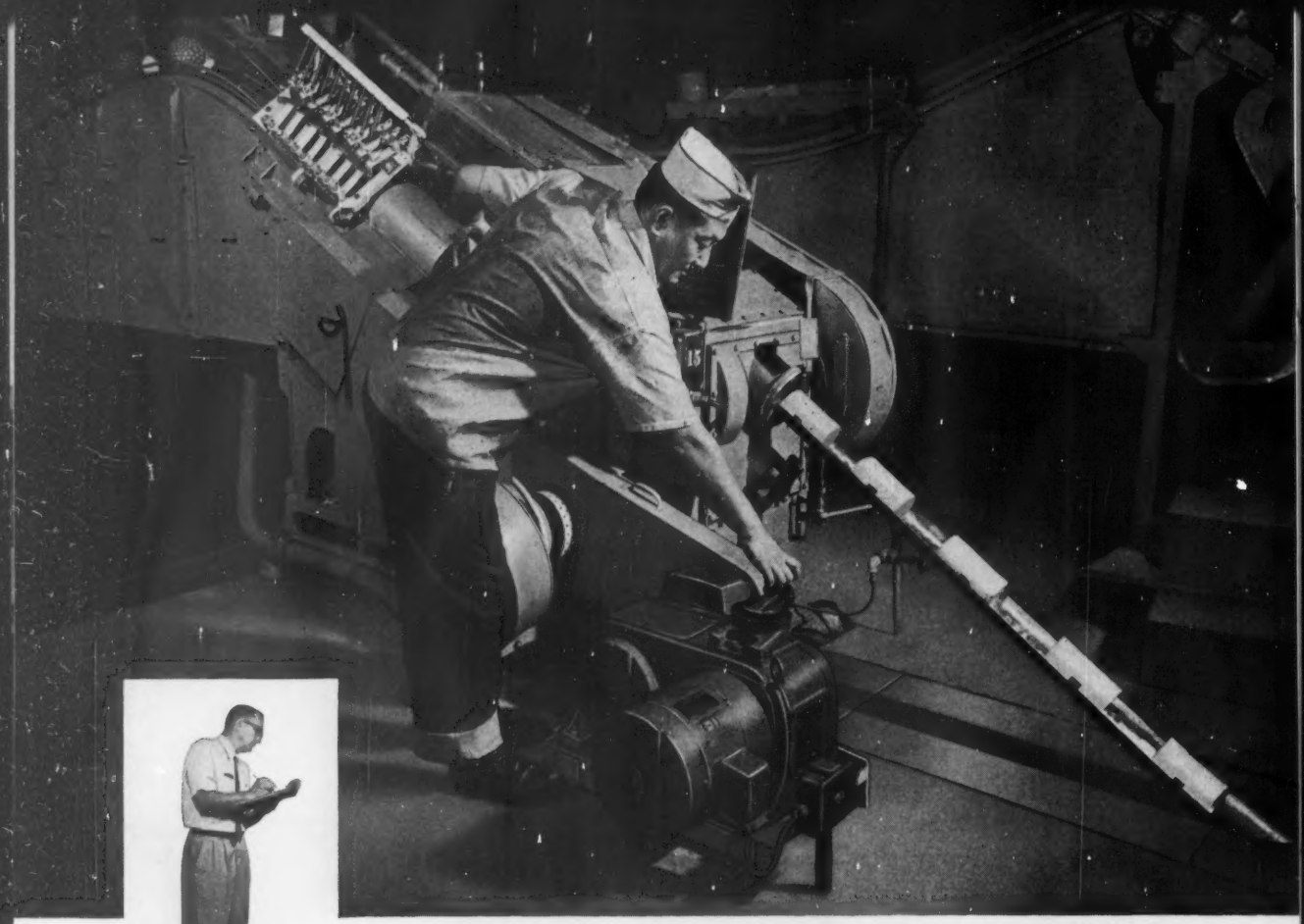


Mr. R. A. Weaver, Electrical Superintendent, Dole Hawaiian Pineapple Company states: **"On the basis of evaluation and comparison with other drives . . . We found General Electric Polydyne® Drives best meet our adjustable-speed requirements."**

At Dole Hawaiian Pineapple Company's Honolulu Cannery, "Ginaca" processing machines can automatically reduce whole pineapples into separate "components" of core, rind, pulp and a cylinder ready for final processing at a rate of up to 6000 per hour. With a constant-speed motor drive it is necessary to stop and start a Ginaca to control output. However, the Polydyne Drive can match the varying conditions at each stage of the processing system. The adaptability of Polydyne Drives reduces the need for supervisory attention and permits maximum processing efficiency.

Dole Company personnel selected General Electric's Polydyne Drives for the quick and smooth response to speed adjustments demanded by their continuous processing system. As Mr. Weaver also commented, "In our evaluations and comparisons with other drives we gave particular attention to ease of belt replacement because this makes maintenance simple and reduces downtime. We found Polydyne Drives far superior to other drives for making belt changes quickly."

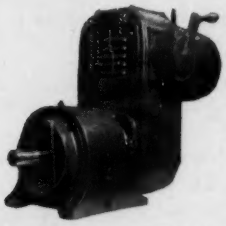
When your application requires low-cost adjustable speed combined with reliability and ease of maintenance, investigate G-E Polydyne Drives. Your General Electric Sales Engineer has full details. Or, write for bulletin GEA-6806, Section 854-05, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

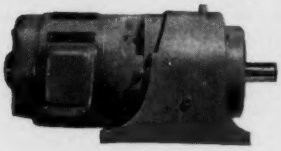
Circle 523 on Page 19

GENERAL ELECTRIC OFFERS A *COMPLETE* LINE OF LOW-SPEED DRIVES 1/8 TO 200 HP

Select from G.E.'s PLUS LINE of compact mechanical power transmission equipment! A full range of ratings is available—many directly from stock.

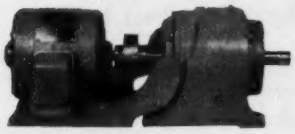


General Electric Polydyne Drive



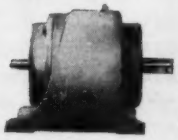
Integral-type Gear Motor

Right-angle Shaft Gear Motor



All-motor Gear Motor

Footed Speed Reducer



Shaft-mounted Speed Reducer

Member of American Gear Manufacturers' Association

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infinite expansion ratio. This special efficiency rating expresses the space power objective of trying to utilize an infinite expansion ratio. In terms of actual published performance, the record for highest specific horsepower is held by the piston expander.

ARS Paper No. 1317-60, "Comparative Rating of Positive-Displacement Engines and Turbines for Cryogenic Power Systems," presented at the ARS Space Power Systems Conference, Santa Monica, Calif., Sept., 1960, 8 pp.

Methodology for Man-Machine Systems Analysis

R. W. Queal Jr., Boeing Airplane Co.

A variety of techniques which human factors specialists in the Boeing Airplane Co. have used to analyze certain man-machine systems and major subsystems. The general theme points up the need for the development of a body of methodology which has general applicability to man-machine system analysis and design problems.

There exists no standard body of methods to perform such work. One is forced to rely on techniques selected or developed for specific jobs.

A first step is to interpret the objective into abstract functional statements. Implicit in each functional statement is a myriad of abstract requirements which must be stated explicitly. This is the second general step. If one way to implement each detailed requirement were selected and grouped together, one system concept would result. There are as many system concepts as there are feasible combinations of implementation schemes.

The most important single problem of system analysis and engineering is the selection of criteria from the number possible.

WESCON Paper, "Methodology for Man-Machine Systems Analysis," presented in Part 4, Session 14, IRE Western Electronic Show and Convention, Los Angeles, Aug. 1960, 3 pp.

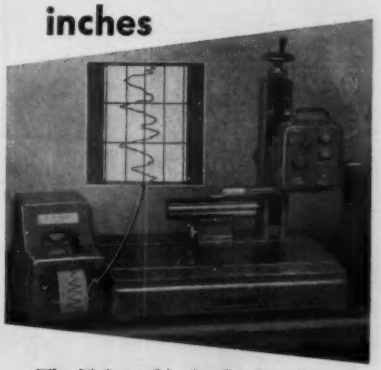
Principles of Analog Computation

Roger G. E. Franks, consultant, Engineering Dept., E. I. du Pont de Nemours & Co.

Abbreviated treatment of analog computer principles together with a

only the **TALYSURF**

truly records surface finish 1 to 2000 micro-inches



The Talysurf is the final authority for surface measurement—a true inkless straight line graph of every irregularity on all finishes—mirror smooth to rough machined.

The .0001" diameter stylus faithfully traces all scratches under a pressure of only 0.1 gram (.0035 ounces). Also provided is the integrating average meter which gives in a single stylus traverse the correct average reading—there is no wavering of the pointer.

For parts that require unquestioned surface accuracy, a check with the Talysurf eliminates time-wasting, costly arguments. The Talysurf is your guarantee of reject-free production, whatever the surface finish specification.

. . . *New* with universal accessories, the Talysurf provides surface analyses on all materials, hard or soft—and shapes, flat or curved. Your surface analysis problem is invited for study.

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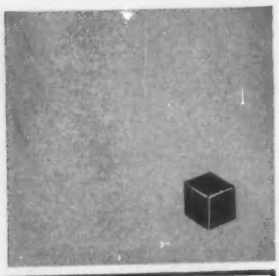
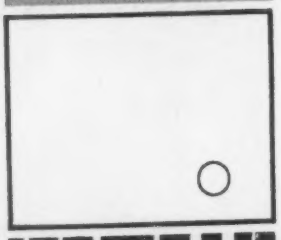
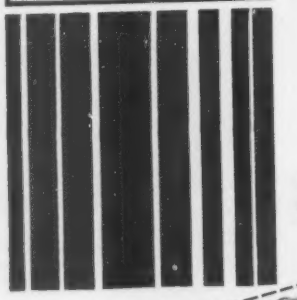


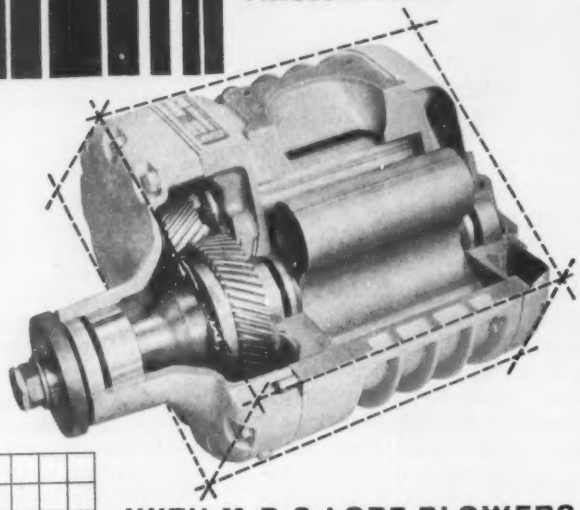
SMALLEST CUBE DIMENSIONS

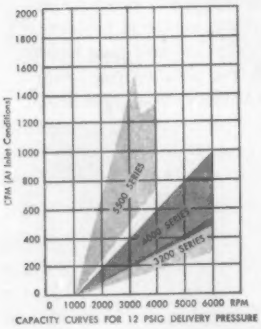


LIGHTEST WEIGHT



WIDEST PRESSURE RANGE





WITH M-D 3-LOBE BLOWERS

If space and weight of the blower is a concern in your design problem, consider this fact. M-D rotary positive blowers because of their unique 3-lobe design require smaller cubic space than any other blowers. A survey shows that a 14 PSI M-D takes 3/4 to less than 1/10 the space of competitive models . . . and in some cases are only 1/10 the weight.

M-D Blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 11 production models range from 50 to 4000 CFM, pressures to 14 PSIG single, 70 PSIG multi-stage.

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A Subsidiary of Miehle-Goss-Dexter, Inc.

few examples. Certain important aspects of programming, such as scaling and problem check-out procedures, are emphasized.

ISA Paper No. 73NY60, "Principles of Analog Computation," presented at the Fall Instrument-Automation Conference and Exhibit, New York, Sept., 1960, 10 pp.

Thermally Regenerative Fuel-Cell Systems

R. E. Henderson, B. Agruss, and W. G. Caple, Allison Div., General Motors Corp.

Thermal systems analysis and a bibliography on thermally decomposable compounds. Five categories of incompatibility for thermally regenerative fuel-cell systems are set up and the reasons for incompatibility are explained. Criteria for compatibility are listed along with compounds fulfilling these conditions. There remains a substantial list of compounds from which more acceptable compounds may be obtained.

ARS Paper No. 1301-60, "Resume of Thermally Regenerative Fuel Cell Systems," presented at the ARS Space Power Systems Conference, Santa Monica, Calif., Sept., 1960, 7 pp.

Modeling of Structures Subjected to Blast Loading

W. E. Baker, Terminal Ballistics Laboratory, Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

A model law for scaling of response to blast loading of structures which undergo large elastic and plastic deformations. On the basis of the analysis and experiments presented in this paper, the similarity principle which describes the modeling of blast waves can be used with equal facility to describe modeling of the response of structures to the transient forces generated by interaction of blast waves with structures.

The law would be expected to be invalid only if the structures were made of materials whose behavior changed markedly with change in strain rate or if "body forces," such as gravity forces, were not negligible.

The scaling applies with no restrictions on amplitudes of motion or of strain amplitudes. Such

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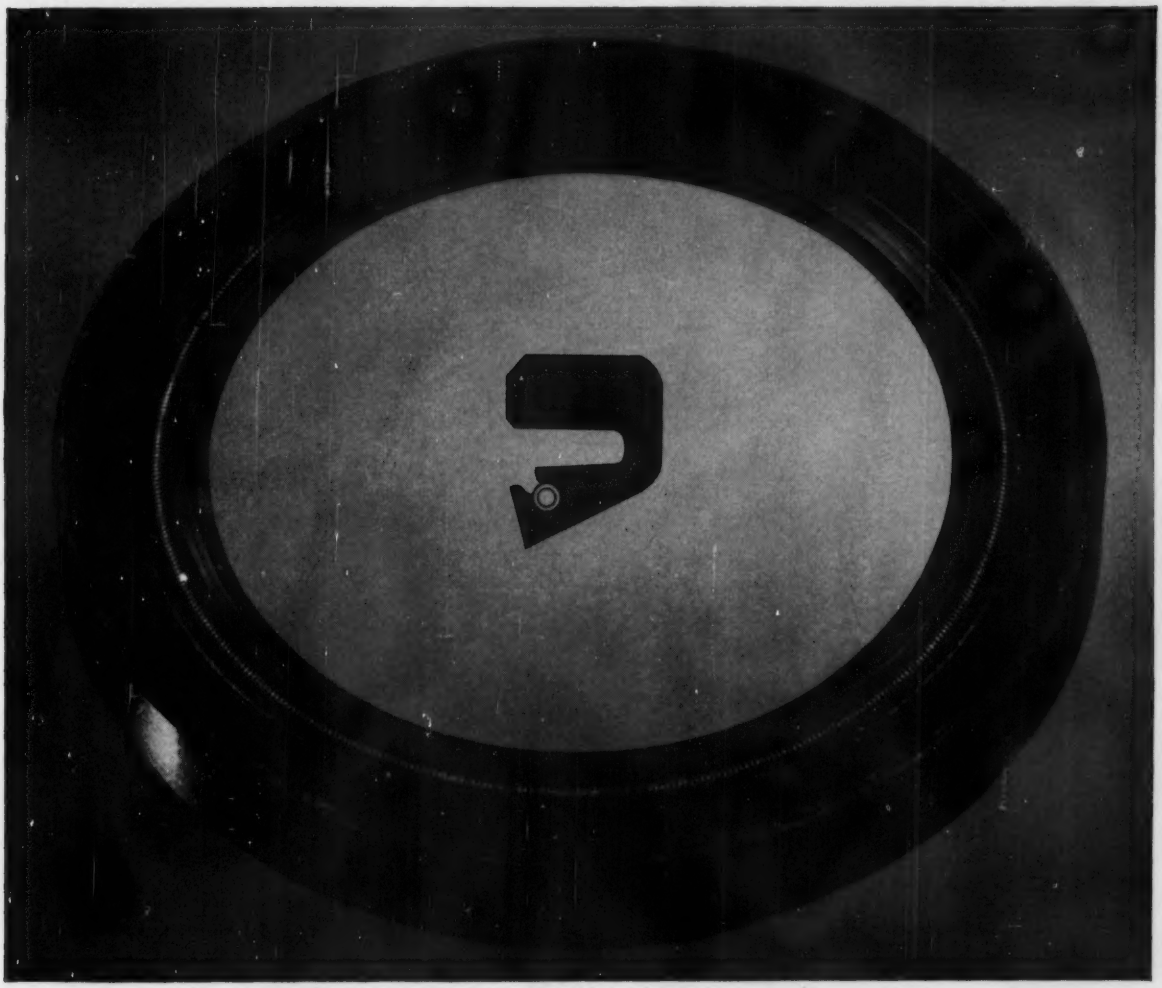

Tame corrosion with J-M Clipper® Seals!

Their all-compound construction

- **prevents rusting in the cavity**
- **provides better bearing protection**
- **simplifies removal and replacement**

The two pictures on this page dramatically demonstrate the importance of an *all-compound* construction where corrosives must be reckoned with. The Clipper Seal shown above has seen service in a severe application. Yet unlike seals of other than all-compound construction, it has come away unharmed and still fit for further service. *Nothing* in a Clipper Seal can rust, or corrode in the cavity, or cause pitting of bore surfaces. In the styles using a garter ring, even the spring is made of stainless steel!

Metal-cased Seal will rust and corrode

A Clipper Seal consists of a soft, flexible lip and a tough, dense asbesto-compound heel, concentrically moulded into one unit. The heel effectively protects the bore from damage, and you'll never need to scrape or refinish the bore surfaces. Clipper Seals come away clean and easy . . . replacement is fast and requires no special tools or adhesives. And for quick, temporary replacement, Johns-Manville produces a special split seal.

Let your J-M Distributor help you select the *right* seal for your service conditions from the wide range of designs, compounds and durometer stocks available. Or for a copy of helpful book PK-71A, write to Johns-Manville, Box 14, New York 16, N.Y. Cable address: JOHNMANVIL. In Canada, write to Port Credit, Ont.

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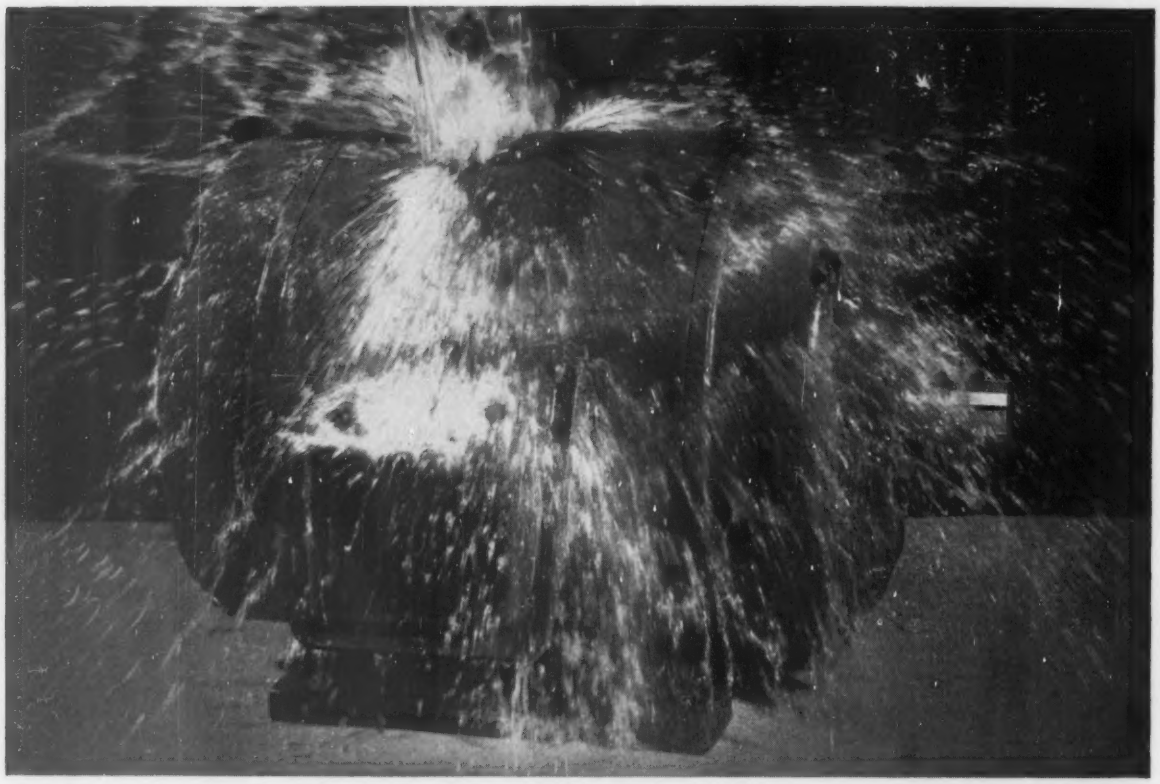

Sudden Splash or Soaking Shower

won't stop a Wagner® DP Motor . . .

Wagner® Type DP Motors are doubly protected by rugged, corrosion-resistant cast iron frames and dripproof enclosures. Splashing or falling liquids, corrosive acids, salts, and alkalies can't stop their smooth operation. Designed to meet a wide variety of applications—including many that used to require splashproof motors—Wagner Doubly Protected Motors pack plenty of power into precious little space, are lightweight, long-lived, and pare downtime and upkeep costs to the bone. Simply put . . . they get the job done. Let your nearby Wagner Sales Engineer show you how these motors can be applied to your needs. Call him, or write for Bulletin MU-223.

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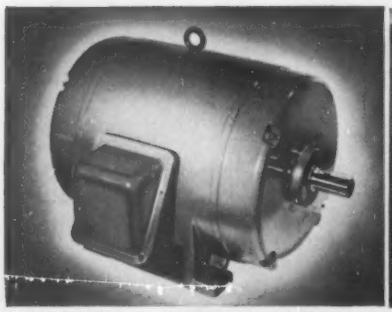
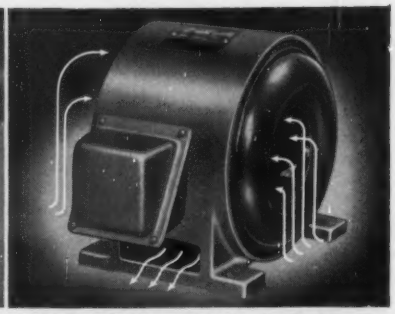


SLEEVE BEARING MODELS AVAILABLE . . . DP Motors are built in NEMA frame sizes 182 through 445U; 1 through 125 hp—1750 RPM—40°C; available with ball bearing construction as illustrated or steel-backed, babbitt-lined sleeve bearings. Larger motors (Type RP) are available through 1000 hp.

CAN BE RELUBRICATED . . . Original factory lubrication will last for many years in normal service, but openings are provided to permit the relubrication that adds years to motor life under severe conditions.



COOL RUNNING . . . Specially designed baffles direct cooling air through the motor to reduce stator temperature, thus increasing motor life. Blowers, cast as part of the rotor, move large volumes of air without noise or vibration.

WM60-20

problems as transverse displacement of slender beams or dynamic buckling of thin-wall shells under blast loading, where quite large deflections can occur, can then be studied by performing accurately controlled small-scale experiments and scaling the test results.

ASME Paper No. 60-APM-18, "Modeling of Large Transient Elastic and Plastic Deformations of Structures Subjected to Blast Loading," presented at the Summer Conference of the Applied Mechanics Div., University Park, Pa., June 1960, 7 pp.

Characteristics of Resistance Strain Gages

Roscoe L. Bloss, physicist, Engineering Mechanics Section, National Bureau of Standards.

A word of caution, and a summary of capabilities. Although resistance strain gages are very useful devices for many applications, their characteristics and limitations must be examined closely when use in a new situation is contemplated. The characteristics and factors which may limit the usefulness of these gages include: Strain sensitivity, temperature sensitivity, resistance instability, shelf life of components, effects of moisture, incompatibility of components, fatigue life, frequency range, magnetostrictive effects, and incompatibility with environment. These factors are discussed and illustrated.

ISA Paper No. 90-NY60, "Characteristics of Resistance Strain Gages," presented at the Fall Instrument-Automation Conference and Exhibit, New York, N. Y., Sept,. 1960, 10 pp.

New Technique in Stress Analysis

R. M. Law, Experimental Engineer, Detroit Diesel Engine Div., General Motors Corp.

A technique, called Photostress, which enables continuous and quantitative observations directly on the stressed object. Photostress technique involves coating the part to be analyzed with a special transparent plastic. When a load is applied to the part, strain in the part is transmitted to the plastic coating, which then becomes refractive. White polarized light gives a complete color picture of the strain dis-

NEW MASSIVE MC NYLON PLATE NOW AVAILABLE!

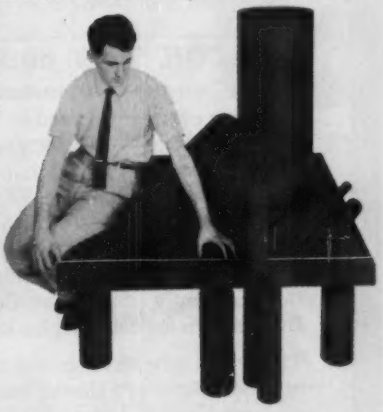
• Huge MC Nylon plate—the largest ever produced—is now available for wear plates, panels, tooling, fixtures and other applications which need nylon's unique mechanical or structural properties.

Polymer's exclusive revolutionary new processing techniques make production of large plate practical with price reductions of 15% under nylon plate presently available. Standard stock availabilities now include thicknesses from ½" up to 4" and in 2' by 4' sections. Availabilities to date were limited to 1½" maximum thickness in 10" widths. MC Nylon now opens new design possibilities and manufacturing economies. On special order plates of over 6" thickness in sections of 4 foot widths and 10 foot lengths can be supplied.

In tubular bars, the specially formulated bearing material now costs less than continuous cast bronze bushings of similar size, with prices up to 50% below other nylons.

MC Nylon tubular bars are made in OD's from 2" to 15" with wall thicknesses of ⅜", ½", ¾" and 1". Rod up to 17" diameter is also available with special larger sizes and shapes made to order. Supplied in Polypenco blue.

Call or write for full information.



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The Polymer Corporation of Pennsylvania
Reading, Pa.
Export Polypenco, Inc., Reading, Pa., U.S.A.

Circle 528 on Page 19

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– IN ANY MATERIAL!

For original design—production salvage and "on-the-job" thread repairs—use *Heli-Coil*® Stainless Steel Wire Screw Thread Inserts.

HELI-COIL Standard Insert
for stronger, smoother, lifetime threads

Permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration, and shock. Made of 18-8 stainless steel wire, this precision-formed *Heli-Coil* Insert has a tensile strength of approximately 200,000 psi. Conforms to military standards and all commercial and industrial thread forms.

HELI-COIL Screw-Lock Insert
eliminates lock wiring and lock nuts

This one-piece wire Screw-Lock Insert provides all the thread protection of the Screw-Thread Insert, PLUS an exclusive resilient *internal* locking feature that eliminates clumsy protruding lock nuts, lock wiring and other supplementary locking devices. It saves cost, space and weight – permits simple streamlined design in standard bosses. Meets military and N.A.S. specifications for locking torque and vibration.

HELI-COIL Shop-pack
for all "on-the-job" thread repairs

Contains everything needed for fast, easy thread repair – *on the spot!* Salvage expensive parts – for pennies! Shop Pack restores threads to original size. Available in U.N.F. and U.N.C. sizes 6-32 to 1½-6. There's a kit for spark plug and pipe thread sizes, too. Each Shop Pack contains a supply of *Heli-Coil* Screw-Thread Inserts with special tap plus inserting tool.

There is a *complete* line of *Heli-Coil* products for every thread need: inserts, taps, tools and gages. Let us help with your design and application problems. Write today for complete information.

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tribution over the entire surface, with highlights on the areas of stress concentration.

Since the change in color is directly proportional to the intensity of the strain, the location, sign, and magnitude of each strain can be determined instantaneously and with great accuracy.

Strain can be measured in static or dynamic condition. The dynamic conditions are only limited by the speed of the recording device, either high-speed movies or photoelectric instruments.

SAE Paper No. 255B, "New Techniques in Stress Analysis," presented at the SAE National Powerplant Meeting, Cleveland, Oct-Nov., 1960, 4 pp.

electrical

Steady-State and Transient Ratings of Electric Wire

R. W. Stineman and G. W. McIntyre, Boeing Airplane Co.

An accurate, reliable method of determining wire ratings. Presently used current ratings are unduly conservative because of large safety factors. With the increasing importance of weight and cost, an accurate, reliable, and easily used method of determining wire ratings has become a necessity. Among the requirements of such a method are:

1. It must be useful for any ambient condition or any installation.
2. It must be useful for steady-state or transient conditions.
3. It may be used for single wires or bundles.
4. It may be used for either direct current or alternating current.
5. It must have flexibility in the time-temperature domain.
6. It must be directly usable and must yield easily understandable results.

AIEE Paper No. 60-1220, "Calculation of Steady-State and Transient Ratings of Electric Wire," presented at the AIEE Fall General Meeting, Chicago, Oct., 1960, 14 pp.

Cryogenics Applications in Electrical-Electronic Design

R. J. Allen, The Martin Co.

Possible applications of cryogenics electronics based on current state of

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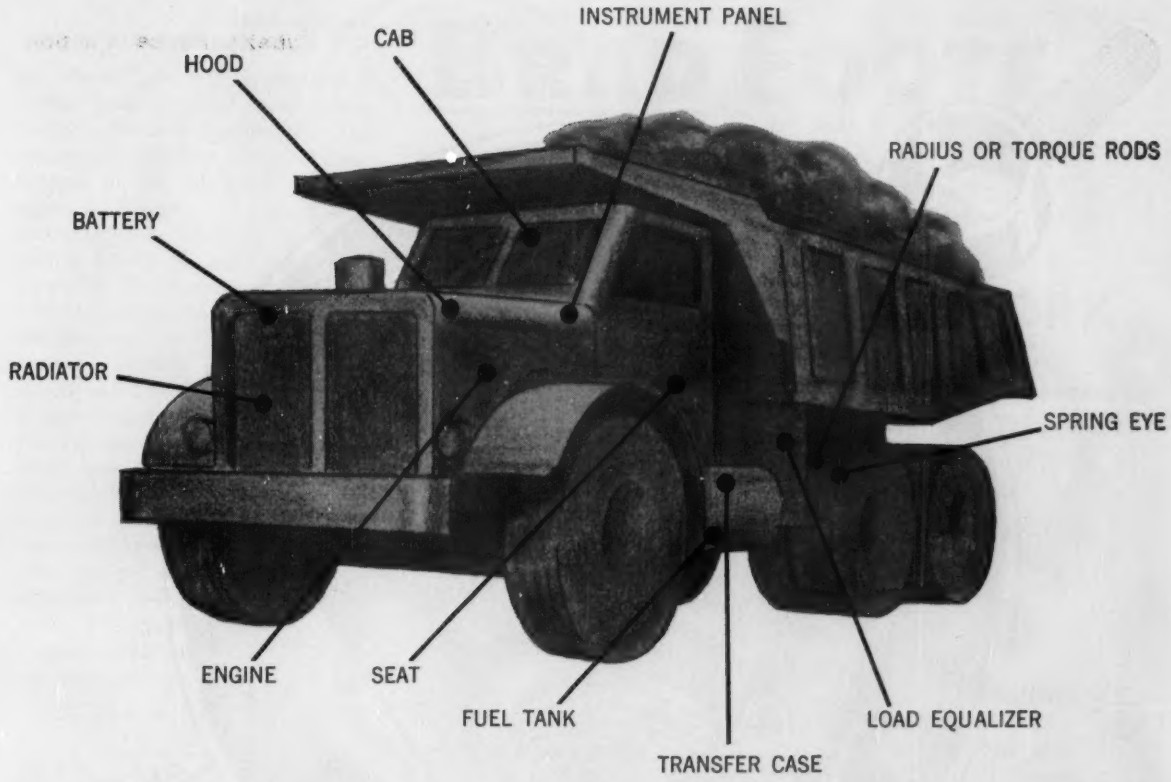


critical points for shock and vibration control

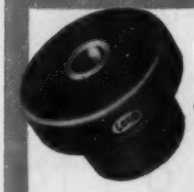
Engineered protection against shock and vibration pays off in *better performance*, *longer service life* and *less maintenance*. This is the experience of a growing number of off-highway, construction and farm equipment manufacturers.

By using flexible LORD Mountings and Joints at key points, they eliminate the efficiency-destroying effects of brutal jolts, vibration, distortion and misalignment.

LORD elastomeric units provide positive cushioned action under severe conditions, outlast metal units and never need lubrication. Tough, service-proved flexing elements are specially compounded elastomers, permanently LORD-bonded to steel members. Design is simple and compact, requires no close tolerances, usually fits existing mating parts.

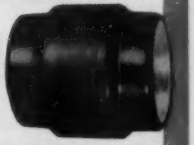
LORD Mountings and Joints are economical, can be specially engineered by LORD to your specific application. Their use eliminates need for "beefing-up" structures, thus permitting increased payloads.

Take advantage of LORD's unsurpassed experience—contact your nearest LORD Field Engineer or the Home Office, Erie, Pa.



Center Bonded Mountings provide flexible support for components, absorb heavy shock loads, isolate vibration and accommodate relative motion without loss of stability. Also feature high unit load capacity and patented rebound protection. Ask for Bulletin 712.

Dynaflex® Joints are long-lasting, lubrication-free bearings or pivots. They accommodate torsional and angular motion, absorb shock and reduce noise and wear. Ask for Bulletin 713.



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BONDED RUBBER

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Circle 530 on Page 19

TubeXperience in action

STST*

*Superior Tool Steel Tubing

ODDS: 1000 TO 1 TO CUT COSTS, IMPROVE PERFORMANCE IN 1001 DIFFERENT APPLICATIONS

Superior tool steel tubing is an excellent material for tools, but equally good for 1001 other applications. Odds are that it will cut costs and improve performance wherever it is used. Type E-52100, an oil hardening grade of high-carbon and chromium alloy steel, has been widely used for such diverse applications as thread guides on hosiery knitting machines, nylon yarn guides, ball bearing races, nozzles for blast cleaning equipment, gear and pinion parts, dental instruments and extrusion mandrels. Type E-1095, a high-carbon steel tubing, is serving as applicators for jewelers' oilers, leather and paper punches, and surgical instruments.

Perhaps you have an application that can benefit from high strength and hardness, good wear resistance, abrasion resistance, shock resistance, and notch toughness. In that case, consider Superior tool steel tubing before you go any farther. It could give you a better product at a lower cost. Send for Data Memorandum #14, a handy guide to your thinking. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Steel

Superior Tube

The big name in small tubing

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All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

Circle 531 on Page 19

the art, and potential application of cryogenics to electrical power-system design. Material properties and component behavior are remarkably altered in the ultracold environment. Masers, superconductive gyros, cooled infra-red detectors, and a family of super conductive electronic components derive improved performance from the low temperature. In many cases, operation depends on phenomena unique at low temperature. The biggest obstacle—creating and maintaining the environment—has already been lessened, and it will be removed with the imminent arrival of small closed-loop cryostats and other developments. The task then will be to exploit the unusual cryogenic phenomena, thereby bringing about improved size, weight, capability, and reliability of electrical and electronic equipment.

AIEE Paper No. 60-1035, "Application of Cryogenics to Electrical-Electronic Design," presented at the AIEE Pacific General Meeting, San Diego, Calif., Aug., 1960, 9 pp.

Thermoelectricity Applications

A. A. Sorensen, The Martin Co.

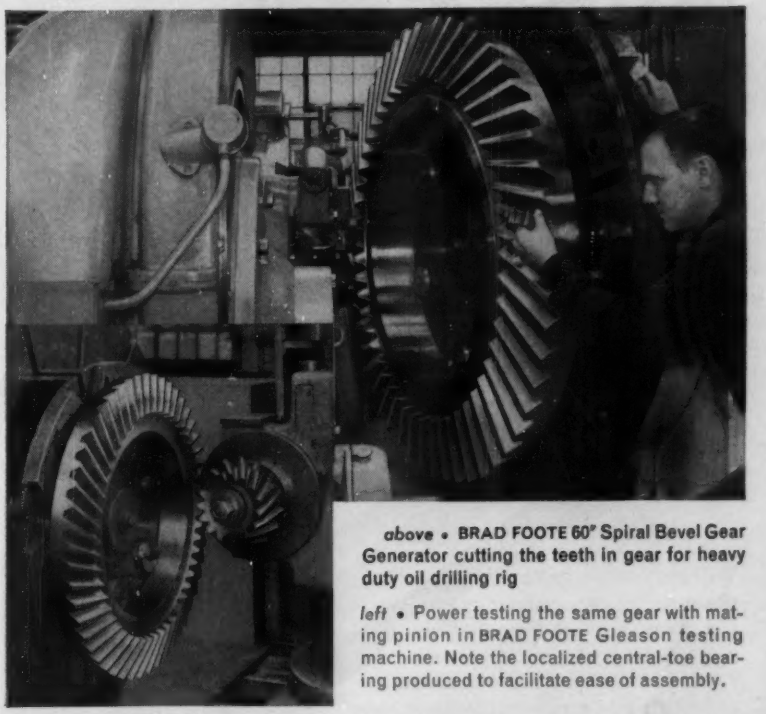
Selection of sources of electrical power from the great variety commercially available. Final choice is governed by an optimization study, taking account of required power level, operating time, and desired characteristics.

The thermopile is a contender for many applications now that solid-state physics studies have brought about more efficient and uniform thermoelectric materials. Compared to other energy-conversion devices it is simple in construction, there being no electrical fluids or extremely close spacings to maintain. Being static, the thermopile has the potential of long life. It operates from electrical, solar, or nuclear heat sources, able to use waste heat, and adapts to various ambient conditions. On the other hand, its specific weight is still high, voltage is low, and time constants are long.

An important use for thermopiles is to supply power continuously to a storage device, such as a battery

BRAD FOOTE gears ...FOR A WORLD AT WORK

SPIRAL BEVEL GEARS
for precision mechanisms and heavy duty power transmission



above • BRAD FOOTE 60" Spiral Bevel Gear Generator cutting the teeth in gear for heavy duty oil drilling rig

left • Power testing the same gear with mating pinion in BRAD FOOTE Gleason testing machine. Note the localized central-toe bearing produced to facilitate ease of assembly.

BRAD FOOTE offers the finest cutting and testing equipment available for the production of precision spiral bevel gears in the widest range of capacities.

These include such diversified drives as: spiral, zerol, right angle, obtuse or acute angle. They may be in sizes from 1" to 60" diameter, 10 DP to 1 DP and from ½" face to 10" face.

For precision mechanisms or heavy duty power transmission, BRAD FOOTE builds your gears from blanks to finished product...fills all your requirements from one source.

ORDER FROM BRAD FOOTE

Your order for BRAD FOOTE Gears will be processed by an experienced organization of gear specialists and produced on the most extensive and versatile facilities available. Maximum performance and your complete satisfaction are assured because no one shares our responsibility.

OTHER BRAD FOOTE SPECIAL EQUIPMENT INCLUDES: High Precision Rack Broaching Machine with capacity up to 1 DP; 134" Precision Gear Shaper; 72" Diameter Shaving Machine

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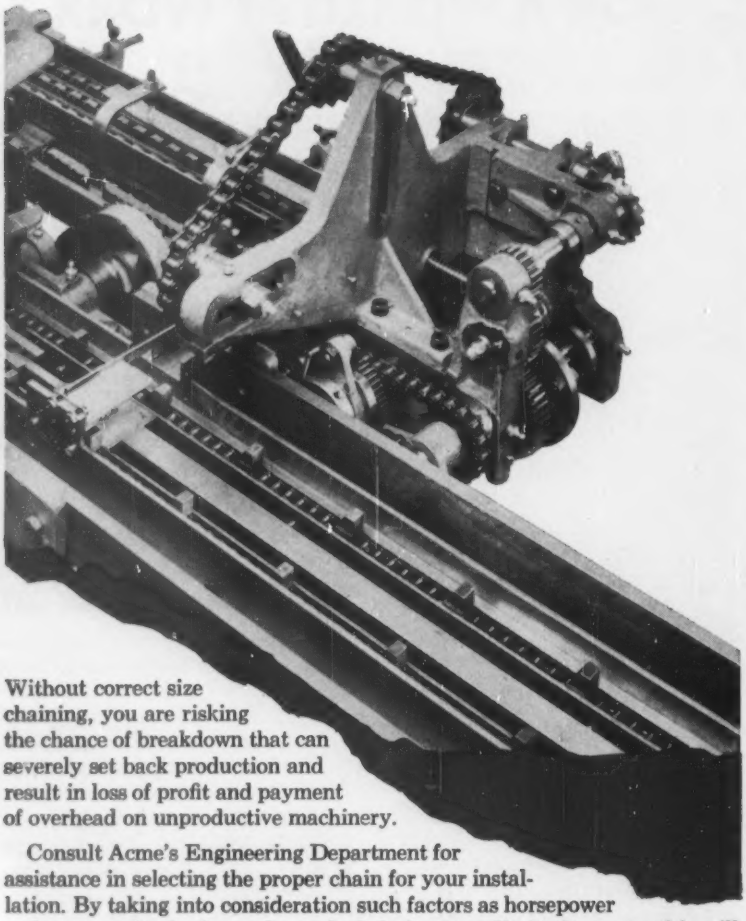
Circle 532 on Page 19

DO YOU HAVE THE BEST CHAIN SELECTION

For Efficient Operation of your installation?



Without correct size chaining, you are risking the chance of breakdown that can severely set back production and result in loss of profit and payment of overhead on unproductive machinery.

Consult Acme's Engineering Department for assistance in selecting the proper chain for your installation. By taking into consideration such factors as horsepower to be transmitted, size and speed of shaft, space limitations, etc. this will determine the standard size of chain required to do the job best. This size or any other can be obtained off-the-shelf from your local Industrial Distributor.

Your Industrial Distributor can supply you promptly with Acme Roller Chains in 12 standard sizes from ¼" pitch to 2½" pitch. He has the full cooperation of our Engineering Department. Contact him.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Write Dept. 6-G for new ill. 100 page catalog with engineering section.

RELIABLE CHAIN DRIVES FOR ALL INDUSTRIES

ROLLER CHAINS, SPROCKETS, CONVEYOR CHAINS, FLEXIBLE COUPLINGS, ATTACHMENTS. (Special and Standard)

or a rotating flywheel, from which energy is withdrawn as needed. In this application the thermopile can be operated at its most efficient load.

AIEE Paper No. CP60-1066, "Thermoelectricity Application Considerations," presented at the AIEE Pacific General Meeting, San Diego, Calif., Aug., 1960, 5 pp.

hydraulic

Surface-Type Hydraulic Filters

H. L. Forman and C. J. Casaleggi, Purolator Products Inc.

Characteristics and capabilities of reinforced paper surface-type and edge-type filters. Both are characterized by the fact that contamination particles are retained essentially on the surface of the filter medium with some entrapment occurring below the surface. Advantages of the extended area, reinforced paper, surface-type filter are low initial pressure drop with large dirt retention and low replacement cost. Edge-type filters, including wire wound metal edge type, wound ribbon, and stacked discs types, offer the user strength and cleanability.

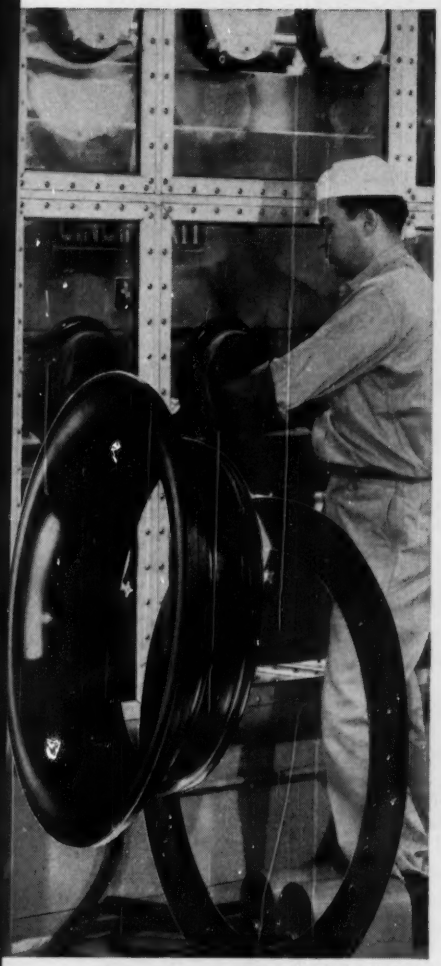
Pore sizes are available in the extended area filters using resin reinforced papers from 2-5 microns to 30 microns. Woven screens of the square or twill mesh type of weave can provide adequate surface filtration in the range from 10 microns to 0.125 in. Wire wound metal edge-type filters have openings ranging from 0.0015 to 0.025 in., while other edge types offer filtration down to the 2 to 5 micron ranges.

As the temperature requirements of hydraulic system increase to the 300 F, reinforced papers in the surface filters must be replaced by newer, stronger media made of nonwoven Nylon, Dacron or Orlon.

As operating temperatures of hydraulic systems increase, more exotic hydraulic fluids are finding greater use. These fluids, in some cases, affect filter element adhesives adversely.

SAE Paper No. 223B, "Surface-Type Hydraulic Filters," presented at the SAE National Farm, Construction and Industrial

Product-Design
BRIEFS
from Durez



ARGONNE NATIONAL LABORATORY

PHENOLIC PORTHOLES? WHAT NEXT!

Atomic engineers have found a good way to seal those big gloves that handle plutonium and its deadly cousins in inert-atmosphere chambers.

The port you see here does this critical job well. It is compression molded of a Durez medium-impact phenolic. It doesn't leak. It also resists shock, corrosion and heat. Its smooth surface won't snag the rubber glove. And it is economical: metal inserts can be molded right in. Except for polishing off flash, it's all finished when it comes off the press.

Have *you* looked into atom-age phenolics lately? They're better, more versatile than ever. To see what they can do for you, check the coupon for our Bulletin D400. It lists properties, uses, advantages of many interesting Durez compounds.

Circle 534 on Page 19

PUT THE BRAKES ON HEAT

No, this isn't a magic powder you sprinkle on a product to make it resist heat. It is a material—Durez phenolic resin—that's used in scores of products as a *bonding agent* to impart controlled degrees of heat resistance.

Brake linings are just one example. Some others: electronic resistor coatings, shell molds and cores for foundry use and automotive generator brushes.

For heat resistance at low cost, you just can't beat phenolic resin. If you have such an application, write us the details and we'll gladly try to help you as we have helped many others.

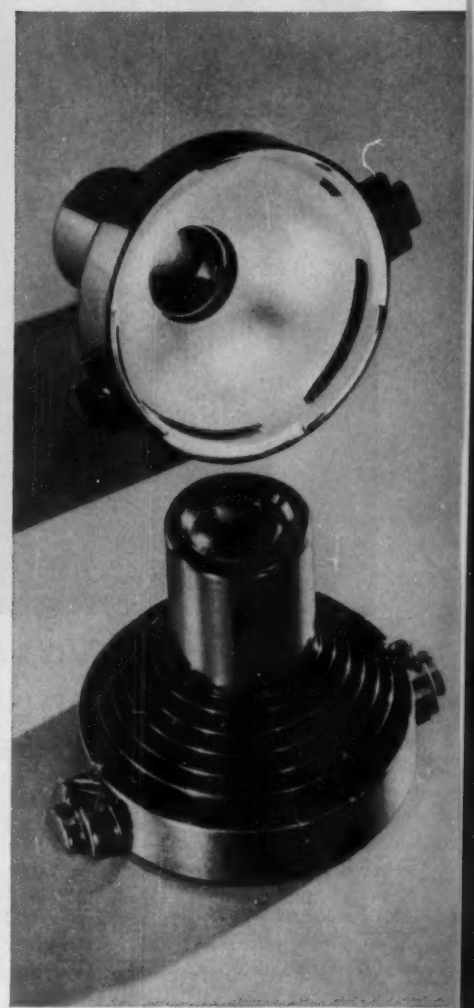
BRIGHT IDEA: PLASTIC-METAL MIRROR

Metallized phenolic saves a costly production step in this housing for a microscope lamp.

In place of a custom-made reflector, the molded phenolic housing has an aluminum mirror deposited right on it by vacuum metallizing.

The Durez compound chosen for this part has the right surface for metallizing, and incorporates high impact strength, low thermal conductivity.

You'll find many helpful ideas like this in *Durez Plastics News*, special bulletin mailed periodically to thousands of product-design men. A check mark on the coupon will bring *News* to you faithfully.



For more information on Durez materials mentioned above, check here:
☐ Phenolic molding compounds—descriptive Bulletin D400 ☐ Phenolic resins—illustrated bulletin describing uses ☐ *Durez Plastics News*—mailed periodically
Clip and mail to us with your name, title, company address. (*When requesting samples, please use business letterhead.*)

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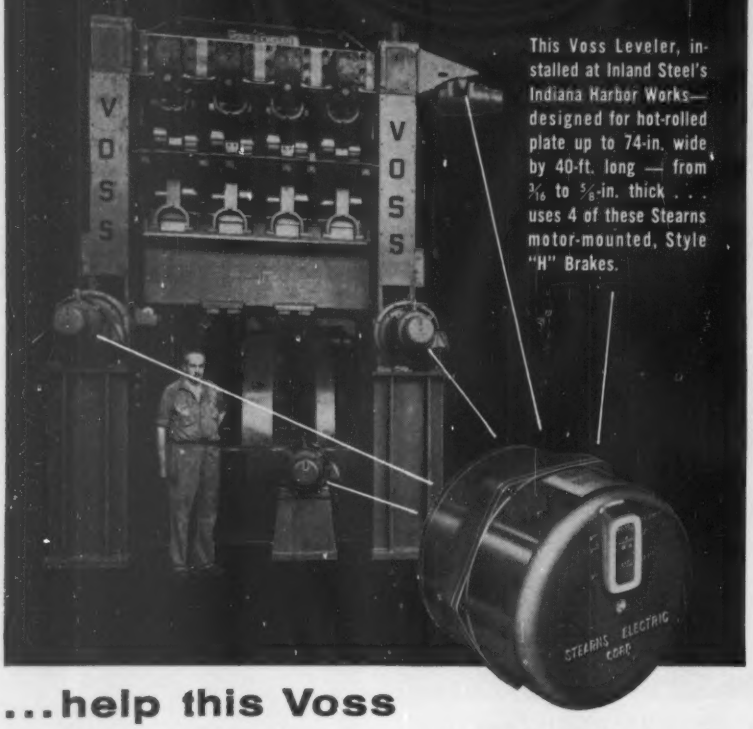
Stearns electro-magnetic
DISC BRAKES
(THE CHOICE OF LEADING MOTOR MANUFACTURERS)



This Voss Leveler, installed at Inland Steel's Indiana Harbor Works—designed for hot-rolled plate up to 74-in. wide by 40-ft. long — from 3/16 to 5/8-in. thick . . . uses 4 of these Stearns motor-mounted, Style "H" Brakes.

...help this Voss Leveler flatten up to 1000 tons per turn — speeds to 282 fpm

Just as *Voss* solves almost any metals-leveling problem at high production speeds—with accuracy and flatness that in many cases equals or exceeds stretcher-level flatness . . . so *Stearns* has, for over 40 years, solved the problems of large, multiple disc Brakes (and Clutches) for the steel industry, cement industry, and other heavy-industry machinery . . . where their long, efficient life — ease of installation and maintenance have been *on-the-job-proved.*

For Superior Performance on ANY Machine . . . Specify Stearns!

For solutions to YOUR Brake and Clutch problems, call the Stearns Representative in your vicinity. Or write, stating your specific requirements, directly to . . .

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THE COMPLETE LINE OF CLUTCHES . . . BRAKES . . . CLUTCH-BRAKES

Machinery Meeting, Milwaukee, Wis., Sept., 1960, 10 pp.

bearings

Starting Forces on Gas-Lubricated Bearings

M. Wildmann, senior research engineer, Autonetics Div., North American Aviation

Examination of the forces acting on a gas lubricated journal bearing at start. Conclusions are:

1. Frictional energy is always larger when the inner member rotates. This would indicate that, whenever possible, bearings of the outside rotating type should be used.
2. Slight increase in the applied starting torque can result in large decreases in the frictional energy. It is therefore important to make the applied torque as large as possible.
3. Frictional energy is always proportional to the kinetic energy of the rotor at the speed at which full hydrodynamic lubrication begins. Comparing various bearings and bearing materials on a weight-per-unit-area basis only can give misleading results.
4. In the absence of a torque applied to decelerate the rotor, frictional energy is always equal to the kinetic energy of the rotor when full hydrodynamic lubrication ceases.

While it is generally recognized that the deformation and wear of the bearing surfaces is a function of frictional energy, no analytical relationship between the wear and the frictional energy can be obtained.

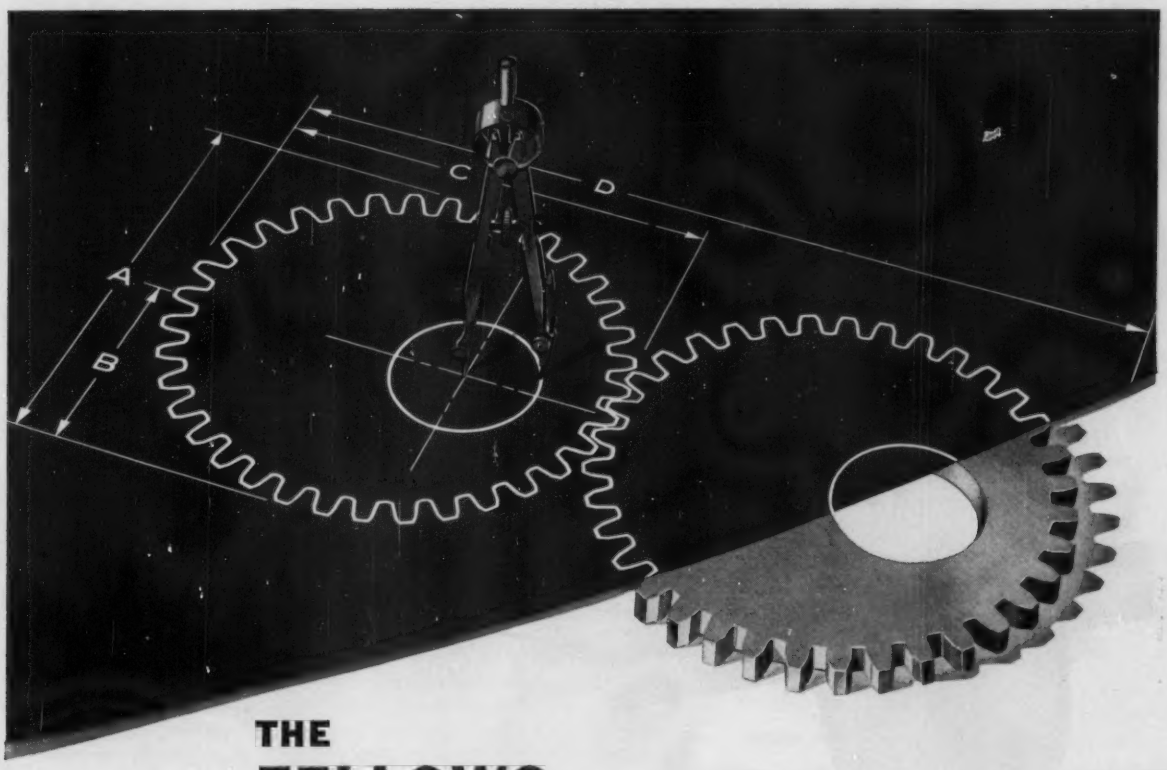
ASME Paper No. 60-LUB-11, *"Consideration of the Starting of Gas Lubricated Bearings," presented at the ASME-ASLE Lubrication Conference, Boston, Oct., 1960, 5 pp.*

lubrication

Grease Lubrication of Plain Journal Bearings

L. J. Bradford, professor emeritus of Machine Design, The Pennsylvania State University; E. M. Barber, senior research technologist, Texaco Research Center; and J. R. Muenger, research associate, Texaco Research Center

Grease-lubricated plain bearings operating with relatively low coefficients of friction and low lubricant



THE FELLOWS GEAR SHAPER

. . . adds a new dimension to your design techniques

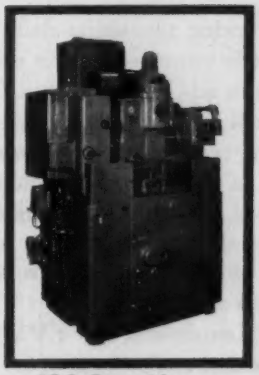
Designs that are right from a functional standpoint, often appear to be impractical from the standpoint of economical production.

To avoid compromising the functional design of non-circular gears or non-involute parts, many companies rely on the unique production capabilities of the Fellows Gear Shaper.

Parts that look complicated (and are complicated to design) become routine jobs in production on the Gear Shaper. Depending on design, some parts are best produced on single purpose machines. Many others can be produced on standard machines using special fixtures and standard, or special, Fellows cutters.

And, of course, the standard machines will generate internal and external spur and helical gears in a range from "miniatures" up to 120" P. D.

"The Art of Generating with a Reciprocating Tool", a fact-packed 48-page catalog, gives details on the versatile Fellows method. May we send you a free copy?



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THE PRECISION LINE

Fellows

Gear Production Equipment

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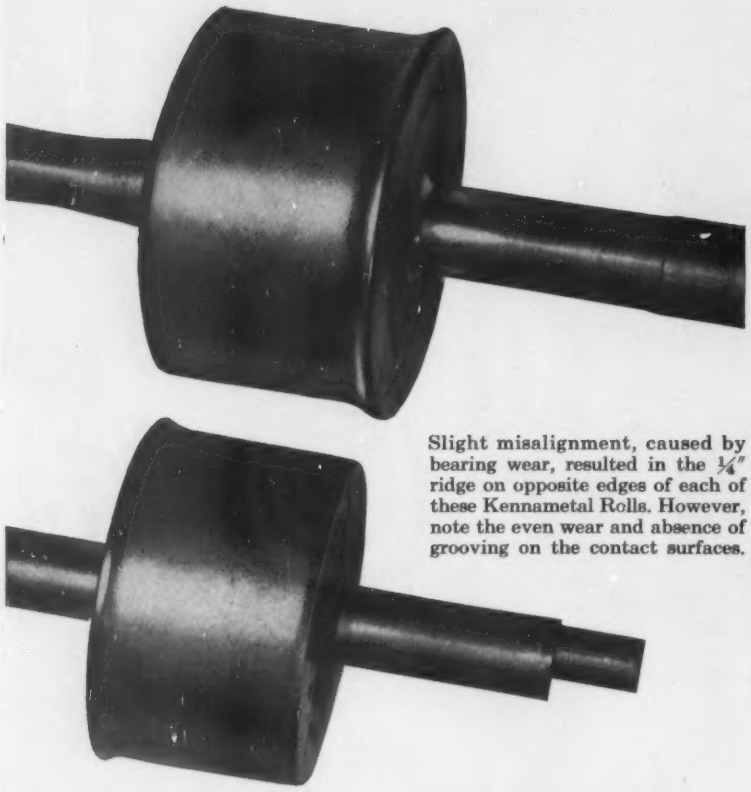


Slight misalignment, caused by bearing wear, resulted in the ¼" ridge on opposite edges of each of these Kennametal Rolls. However, note the even wear and absence of grooving on the contact surfaces.

KENNAMETAL* CRUSHER ROLLS OUTLAST STEEL 72 TO 1

Working two shifts daily for 72 weeks, these Kennametal Crusher Rolls processed over a million pounds of highly abrasive aluminum oxide and ferro tungsten. Then they were removed, reground and put back into service. In the same operation, steel crusher rolls became grooved after only one week, and had to be removed.

In another application, extremely abrasive aluminum nickel alloy—used in permanent magnets—was successfully reduced by Kennametal tungsten carbide rolls to —100 mesh with no contamination. *High iron contamination encountered with previously used steel crusher rolls was eliminated.*

Kennametal has a YME up to 94 million psi . . . 3 times that of hardest steel. Chances are this extreme hardness, plus great resistance to abrasion and deformation can save *you* money through increased roll life and the virtual elimination of contamination.

Find out how Kennametal is used for other applications where contamination and severe wear are problems. Write for Booklet B-666, "Proven Uses" (more than 80 applications of Kennametal), KENNAMETAL INC., Dept MD, Latrobe, Pennsylvania. 33950

*Trademark

INDUSTRY AND KENNAMETAL ...Partners in Progress

consumption as shown by an experimental investigation on 3½-in. diam bearings. Phenomena demonstrated are: Formation of a "rheodynamic" load-carrying film; evidence of thixotropic behavior; and effects of variation of load, speed, clearance, feed rate, and lubricant properties.

Conclusions are:

1. Under appropriate conditions, thick (rheodynamic) film lubrication is achieved in grease-lubricated journal bearings.
2. Grease-lubricated plain bearings can be operated with relatively low coefficients of friction and grease supply. Such bearings are worthy of further investigation and of consideration for applications where loads are high, speeds are moderate, and where the dissipation of frictional heat is not dependent upon high lubricant flow rates.
3. Thixotropic as well as nonNewtonian effects are exhibited in grease-lubricated bearings which are not operating under equilibrium conditions.

ASME Paper No. 60-LUB-5, "Grease Lubrication Studies With Plain Journal Bearings," presented at the ASME-ASLE Lubrication Conference, Boston, Oct., 1960, 8 pp.

materials

Plastics in Human Engineering

A. M. Blumenfeld, Rohm & Haas Co.

Acrylic plastics applications in which the principles of human engineering, or "ergonomics," are decisive considerations. Color, light, shape, texture, written messages, and pictured images are sensory methods employed to transmit information. Acrylic plastics probably offer the best combination of properties among all plastics for the task of successfully bridging the man-machine gap.

Design factors which lead to end products should be considered in this sequence: 1. Define the function. 2. Understand the physical and mental limitations of the 90th percentile of those humans who will operate the machine. 3. Arrange controls in an orderly manner based upon steps 1 and 2. 4. Employ light, color, shape, texture, messages, and pictures to simplify the

GENERAL ELECTRIC

now!

Tri-Clad '55' motors with THERMO-TECTOR* system

WARRANTED

against burnout from overheating

For the *first time* General Electric offers you a motor with such *positive* protection it is WARRANTED in writing against overheating burnout!

G.E.'s exclusive new THERMO-TECTOR system gives Tri-Clad '55' motors truly *inherent* over-temperature protection. Unique variable shut-off feature allows motor to deliver *full power potential* under all operating conditions. Fail-safe THERMO-TECTOR system has simple, two-lead hookup.

*Trade-mark of General Electric Co.

For the first time General Electric offers you a motor with such *positive protection* it is WARRANTED against *overheating burnout*

TURN PAGE FOR FURTHER INFORMATION ➡ ➡ ➡

NOW - A Motor *Warranted in Writing* Against Overload Burnout!

General Electric Company warrants to the Purchaser that the Tri-Clad '55' motor with Thermo-Tector system delivered hereunder will:

(a) **Not burn out because of overheating resulting from overload, lack of ventilation, single-phasing, stall, high ambient, or voltage unbalance, as long as the Thermo-Tector switches are connected into the control circuit so that power to the motor is removed when an overtemperature condition occurs;**

(b) **Be free from defects in material, workmanship and title; and**

(c) **Be of the kind and quality designated or described in the contract.**

The foregoing warranty is exclusive and in lieu of all other warranties whether written, oral, or implied (including any warranty of merchantability or fitness for purpose). If it appears within one year from the date of shipment by General Electric Company that the equipment delivered hereunder does not meet the warranties specified above and the Purchaser notifies the General Electric Company promptly, the General Electric Company shall thereupon correct any defect, including non-conformance with the specifications, at its option, either by repairing any defective part or parts or by making available at the General Electric Company's plant, a repaired or replacement part.

The liability of the General Electric Company to the Purchaser (except as to title) arising out of the supplying of the said equipment, or its use, whether on warranty, contract or negligence, shall not in any case exceed the cost of correcting defects in the equipment as herein provided and upon the expiration of said one year, all such liability shall terminate. The foregoing shall constitute the sole remedy of the Purchaser and the sole liability of the General Electric Company.

General Electric's *exclusive* THERMO-TECTOR system is available now on *all* Tri-Clad® '55' motors in frames 254U-445U. Contact your General Electric Apparatus Sales Office or Authorized Distributor *today* for details on this NEW FULLY WARRANTED MOTOR PROTECTION SYSTEM. Or, write for Bulletin GEA-7092, Section 866-04, Schenectady 5, N. Y.

SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL ELECTRIC

Circle 538 on Page 19

task of the human senses. 5. Design mechanical components of control devices consistent with step 4. 6. Connect controls to functional portions of the machines with due consideration for access and servicing.

Acrylic plastics offer certain advantages as sensory connectors. Specific examples show the latest thinking on their uses with light, color, shape, texture, messages, and images.

SPE Paper, "Acrylic Plastics Applications in Business Machines," presented at the Regional Technical Conference, Binghamton, N. Y., Sept., 1960, 13 *pp.*

Thermoelectric Generator Materials

R. C. Miller and R. W. Ure, Jr., Westinghouse Research Laboratories

A summary of the properties of the best materials known at present for use in thermoelectric generators. These materials include: Bi_2Te_3 and its alloys, PbTe, the III-V compounds, MnTe, GeTe, and CeS. Theoretical maximum efficiency of 18 per cent would be obtained with these materials between 30 and 1030 C, provided that all the design and fabrication problems can be solved.

ARS Paper No. 1273-60, *"Thermoelectric Generator Materials," presented at the ARS Space Power Systems Conference, Santa Monica, Calif., Sept.,* 1960, 7 *pp.*

TO OBTAIN COPIES of papers or articles abstracted here, write directly to:

AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ARS—American Rocket Society, 500 5th Ave., New York 36, N. Y.

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ISA—Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

SAE—Society of Automotive Engineers, 485 Lexington Ave., New York 17, N. Y.; papers 50 cents to members, 75 cents to nonmembers.

SPE—Society of Plastics Engineers, 65 Prospect St., Stamford, Conn.

WESCON—Western Electronic Show and Convention, Convention Record, Part 4, $1.80 to IRE members, $6.00 to nonmembers, available from Institute of Radio Engineers, 1 East 79th St., New York 21, N. Y.

Are Small Precision Metal Parts Disturbing Your Sleep?

The manufacture of small precision metal parts—in large volume—can sometimes take on the aspects of a bad dream. The problems are frequently numerous and complex. Their solution calls for specialized experience.

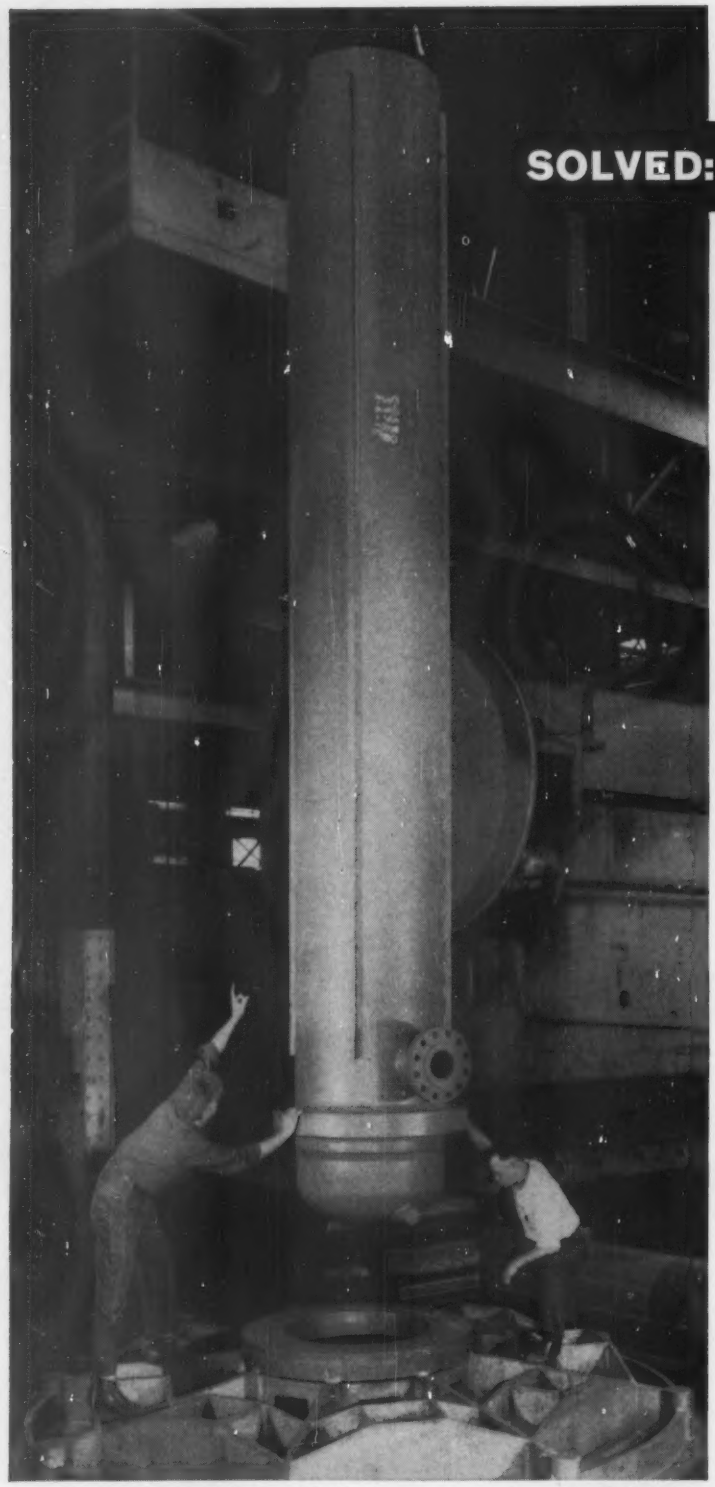
Torrington is the leading specialist in this field. We have the skill, engineering experience and manufacturing facilities to produce—at high speed and economical cost—a tremendous variety of small metal parts of exceptional precision and uniformity.

If you have such parts to be manufactured in large quantities, why not let Torrington solve your entire problem? Write us for complete information—or better yet, send us a blueprint, and we'll be prompt in making our recommendation.

progress through precision **SPECIAL METAL PARTS**

THE TORRINGTON COMPANY Torrington, Connecticut

Circle 539 on Page 19



Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

SOLVED: by Sandusky Centrifugal Casting

Blaw-Knox chooses 10-ton SANDUSKY CASTING for giant slabbing mill

When an 18½-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

This 10-ton carbon steel cylinder, 32" O.D. with a 3½" wall, functions as an accumulator in the mill's hydraulic roll balancing system. Essentially a pressure vessel, it simultaneously supports the ram and ballast weighing 226 tons—the weight required to develop constant operating pressure of 1000 p.s.i.

"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18½ foot length met all our requirements of cost, stability, and strength."*

Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

Write to us at Sandusky, Ohio. Ask for latest Bulletin #200.

SANDUSKY ® **CENTRIFUGAL CASTINGS**

FOUNDRY & MACHINE CO.

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

Helpful Literature
for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Gear-and-Pinion Combinations

New combinations of zinc die-cast, one-piece gear and pinions are listed in Catalog 3001-B. Engineering drawings and tables describe new, integrally cast gear - and - pinion combinations for gear and hub with hole; gear and pinion with hole; gear and pinion with shaft; flanged pinion with hole; flanged pinion with shaft; cup gear and hub with hole; gears and pinions with special features. 10 pages. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.

Circle 701 on Page 19

Wire Components and Assembly

New edition of wire component and assembly manual features case histories of how design engineers cut costs and improve their products through the use of wire and strip-metal components. Manual also describes the principal types of wire available for component construction, the most popular finishes, wire sizes, and variety of end treatments, threading, and forming treatments possible. 24 pages. Custom Design Dept., E. H. Titchener & Co., 57 Clinton St., Binghamton, N. Y.

Circle 702 on Page 19

Coaxial Plugs

Catalog supplement BNC-A describes BNC series of RF coaxial plugs. Designed for small coaxial cables, plugs are lightweight, weatherproof, and manufactured according to military specification MIL-C-3608. Catalog includes nomenclature, mating functional diagram, assembly instructions, and photos, drawings, and specifications for the jacks, plugs, receptacles, adapters, and other accessories. 16 pages. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 703 on Page 19

Teflon-Lined Bearings

Spherical bearings and rod ends lined with Teflon are described in a new bulletin. Catalog lists advantages of the linings in Unibal rod ends and plain spherical bearings. Tables provide information on sizes available, and on load ratings. Dept. MD, Heim Co., Fairfield, Conn.

Circle 704 on Page 19

Fluid-Power Equipment

Gear pumps, control valves, and motors, and their application on mobile equipment and production machinery, are the subjects of General Bulletin 10-001. Bulletin contains photographs and cutaway drawings illustrating the construction and design features of each of the various components, and also provides comprehensive performance data. Also described in detail are the construction features incorporated in Hydreco pumps and motors, and the advantages of the Hollow-Plunger control valve. 8 pages. Hydreco Div., New York Air Brake Co., 9000 E. Michigan Ave., Kalamazoo, Mich.

Circle 705 on Page 19

Wiring-Installation Equipment

Catalog 159-D describes and illustrates complete line of wireways, fittings, and enclosures designed and manufactured to meet JIC and NEMA standards. A wide variety of liquid-tight units is included for applications where wiring must be protected against dust, dirt, oil, water, and coolants. Complete data for all items include dimensional drawings plus exact specifications. 16 pages. Keystone Mfg. Co., 23328 Sherwood Rd., Warren, Mich.

Circle 706 on Page 19

Flexible Couplings

Catalog 70 gives engineering, application, capacity, and dimensional data on dihedral spindle couplings as well as Series D-100 and D-3000 dihedral gear-type flexible couplings. Couplings for use on mills and allied equipment throughout the ferrous and nonferrous metal, paper, rubber, chemical, food, and other industries are illustrated. Included is a two-page question, answer, and sketch sheet to facilitate outlining individual requirements. 12 pages. Ajax Flexible Coupling Co. Inc., Westfield, N. Y.

Circle 707 on Page 19

Instrument Bearings

Three technical data sheets contain dimensional specifications and load factors for new R2, R3, and R4 instrument bearings. Units are made to ABEC Class 7 tolerances. 2 pages each sheet. Miniature Precision Bearings Inc., Precision Park, Keene, N. H.

Circle 708 on Page 19

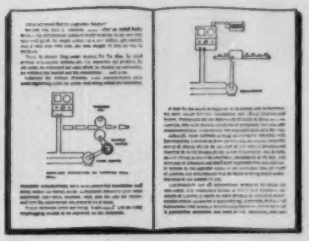
Spray Finish

Folder describes Bronzeless Gold spray finish, which simulates the appearance of fine bronze powders. It gives product data on the Bronzeless Gold systems for metals and thermoplastics, shows color chips of standard colors, and typical applications by appliance and electronic manufacturers. 2 pages. Bee Chemical Co., 2700P E. 170th St., Lansing, Ill.

Circle 709 on Page 19

BUILD LOW-COST AUTOMATIC PROTECTION AND REGULATION INTO YOUR EQUIPMENT!

. . . This free book tells you how!



Now there's a simple, inexpensive way to protect, regulate, and automate *any* electrically-powered equipment — from production machinery to conveyors and packaging systems. A designed-in Mek standard load control does it all, by sensing the telltale deviations in motor input current that warn of impending overload damage . . . excess speed, pressure, or torque . . . or human error.

Responding instantly to predetermined degrees of overload or underload, the Mek load control automatically initiates any desired action — stop, start, signal, index, reverse, change speed, compensate, trip, or recycle.

With a built-in Mek load control, end-points can be established to control stamping, crushing, grinding, or mixing operations. Material feed rates, tool-to-work force, and conveyor operation are automatically regulated. Hundreds of mechanical functions now dependent on human alertness can be easily automated to protect equipment and material — increase production flow.

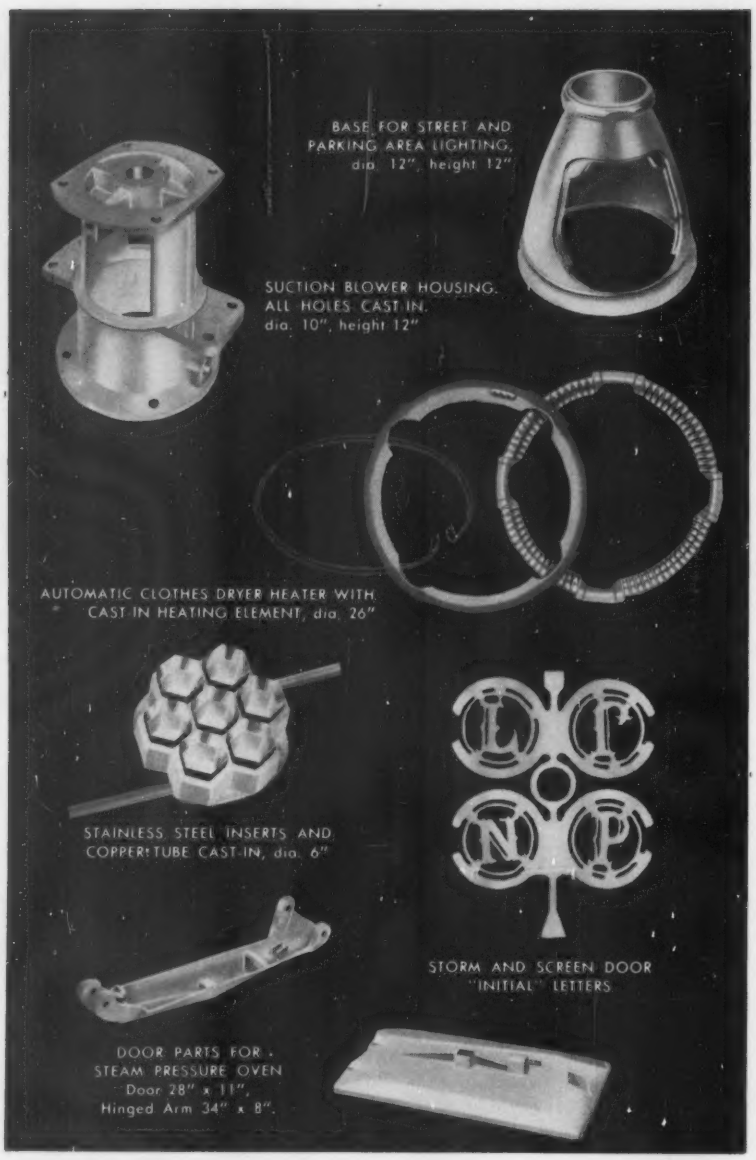
Send today for your free book of actual design applications. Learn how Mek load controls enable designers to build added performance and sales appeal into production equipment for metalworking, food processing, textiles, papermaking, and other industries.

MEK

Machinery Electrification, Inc.

64 Hudson St., Northboro, Mass.

Circle 541 on Page 19


BASE FOR STREET AND PARKING AREA LIGHTING, dia. 12", height 12"
SUCTION BLOWER HOUSING. ALL HOLES CAST IN. dia. 10", height 12"
AUTOMATIC CLOTHES DRYER HEATER WITH CAST IN HEATING ELEMENT, dia. 26"
STAINLESS STEEL INSERTS AND COPPER TUBE CAST IN, dia. 6"
STORM AND SCREEN DOOR "INITIAL" LETTERS
DOOR PARTS FOR STEAM PRESSURE OVEN Door 28" x 11", Hinged Arm 34" x 8".

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progress tomorrow

The method of casting that assures density, homogeneous structure, with surfaces that take a high finish. Illustrated castings indicate how other metals are cast with aluminum to meet specific performances. For more ideas and recommended applications, write for new brochure. Our permanent mold engineers will be happy to work with you.

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Circle 542 on Page 19

HELPFUL LITERATURE

Clamps, Brackets, Shims

Engineering Design Manual 212G offers a listing of materials and specifications, recommended application, and the latest technique for mounting tubing, wiring, and similar hardware. It also includes a description of complete line of clamps, brackets, shims, and line supports for almost any application. Pictures, engineering drawings, and tables are included. 76 pages. Engineering Dept., TA Mfg. Co., 4607 Alger St., Los Angeles 39, Calif.

Circle 710 on Page 19

Metal Spinning

Monthly "Notes for an Engineer's File" cover case histories of a broad variety of unusual metal-spinning applications, complete with technical data. Military, industrial, agricultural, and other fields are covered. 2 pages each month. Spincraft Inc., 4131 W. State St., Milwaukee, Wis.

Circle 711 on Page 19

Alloy Iron Properties

Bulletin 158 charts the engineering properties of Meehanite metal, Ni-Resist iron, Ni-resist ductile iron, and ductile iron. Included are the mechanical and physical properties and chemical composition covering a wide range of centrifugally cast irons. Bulletin also describes and illustrates component parts and assemblies produced by the centrifugal method. 8 pages. Centrifugally Cast Products Div., Shenango Furnace Co., Dover, Ohio.

Circle 712 on Page 19

V-Seals

Form F-100 describes Fluorlastic V-seals which meet high-temperature, zero-leakage requirements. Brochure gives general information and diameters available. 2 pages. Joclin Mfg. Co. Inc., Lufbery Ave., Wallingford, Conn.

Circle 713 on Page 19

Lock Washers

"This Washer Locks" demonstrates advantages of Shakeproof lock washers in various applications. Book shows the many features of the washers, and contains informative schematic drawings, charts, and photographs. Actual examples of use are illustrated. Card accompanying the catalog offers 1000 free washers for testing. 8 pages. Shakeproof Div., Illinois Tool Works, St. Charles Road, Elgin, Ill.

Circle 714 on Page 19

Circular Chain

Designed to operate on curves, new circular chain is described in Bulletin 8. Most common use of the chain is to act as a transfer medium from one straight-line conveyor to another. Bulletin provides application, dimensional, and operational information. 4 pages. Acme Chain Corp., Holyoke, Mass.

Circle 715 on Page 19

Reeves completes redesigned Motodrive line with 25, 30 and 40 hp. "600" in addition to

¼	½	¾	1	1½	2	3	5	7½	10	15	20	HP.

UP TO **40** HORSEPOWER **NEW**

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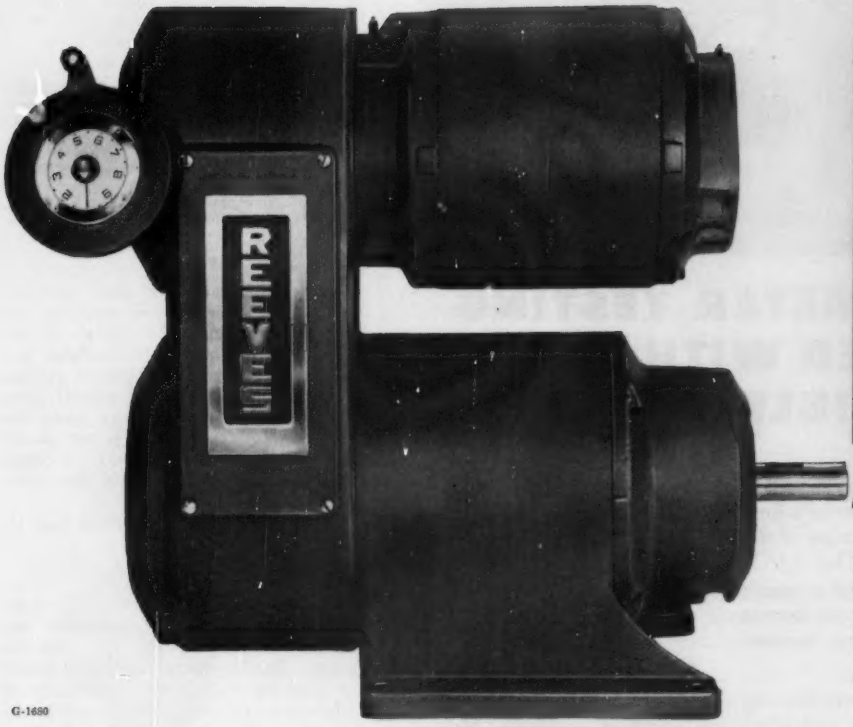

The Reeves adjustable speed "600" gives you up to 3:1 speed range. Infinitely variable output speeds as high as 2150 rpm. or as low as 76.5 rpm., with speed reducer. Full line provides hundreds of space-saving assemblies, manual or automatic controls. Write for complete information.

G-1680

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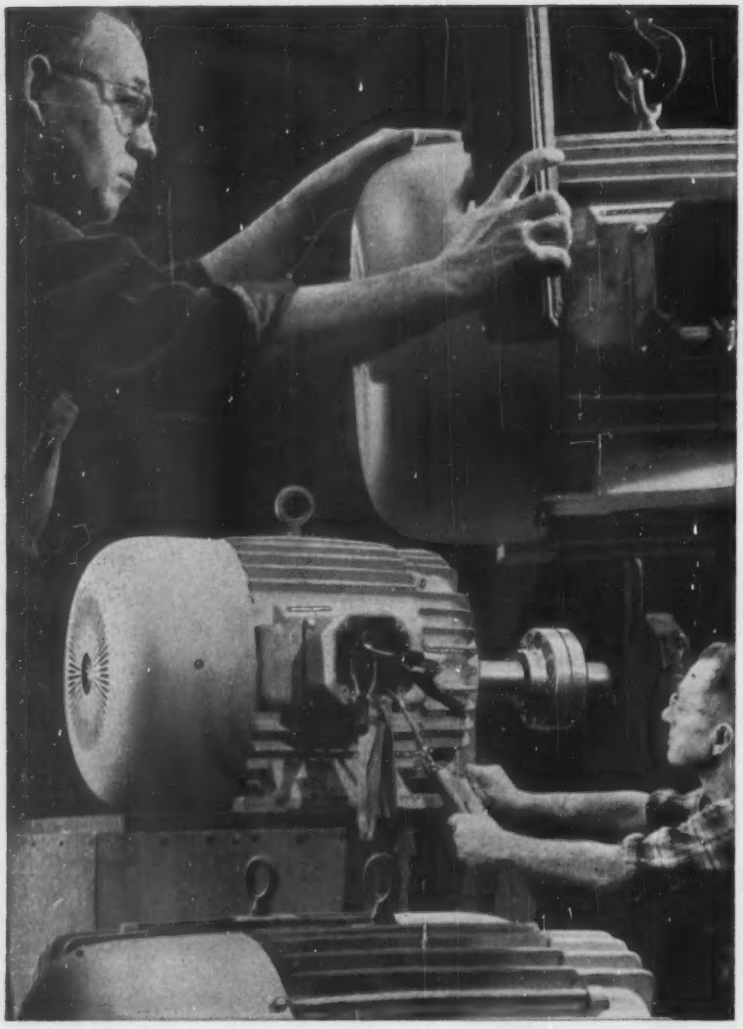
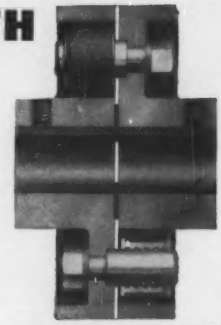
Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.



DYNAMOMETER TESTING TIME SAVED WITH AJAX FLEXIBLE COUPLINGS

Hours are saved by one of America's foremost motor manufacturers because of the quick hook-up made possible by AJAX Flexible Couplings. Their quick connect and disconnect provides practically instant engagement and disengagement between motors and dynamometers.



Cross Section of AJAX Rubber-Cushioned, Sleeve Bearing Coupling.

AJAX Rubber-Cushioned, Sleeve Bearing design also saves line-up time and eliminates end-float problems. Motors being tested range from 40 to 150 HP.

Write for complete information on AJAX Rubber-Cushioned and Dihedral Gear Type Couplings.

AJAX®

AJAX FLEXIBLE COUPLING CO. INC.

102 Portage Road Westfield, N. Y.

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Electronic Controls

New Catalog 60 describes high-speed, ultrasensitive, and impulse-actuated controls. Also included are tubeless photoelectric controls, safety controls, photoelectric, and electronic timing controls. Many pictures and tables describe controls with built-in sensing heads, remote sensing heads, and miniature remote sensing heads; plug-in mounted controls; wide selection of light sources with built-in and remote heads, and with miniature heads. 24 pages. Autotron Inc., Box 722X, Danville, Ill.

Circle 716 on Page 19

O-Ring Type Seal

Form 423 presents information on Tetraseals, designed for direct O-ring substitution, size for size, from 3/16 to 15 in. ID. Bulletin presents application and general information, tables of dimensions of seals for static and dynamic applications, and table of compounds. 12 pages. Goshen Rubber Co. Inc., Goshen, Ind.

Circle 717 on Page 19

Cylinder Force Calculator

New chart enables quick determination of the size of hydraulic or pneumatic cylinders required to perform a given work function. Chart is durable, dull-finished, varnished cardboard which can be wiped clean with a damp cloth. Frosted plastic straightedge is permanently affixed. Complete line of hydraulic and pneumatic cylinders and related products is shown on back of chart. Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio.

Circle 718 on Page 19

Limit Switches

Loxswitch heavy-duty and precision limit switches for machine tools are described in Bulletin 701. Many of the 45 contact arrangements available are shown. Operating data, ampere ratings, principal lever styles, dimensional data, and ordering instructions are given for each switch. Major features are shown with cutaway model drawings. 4 pages. R. B. Denison Mfg. Co., 386 Broadway, Bedford, Ohio.

Circle 719 on Page 19

Urethane Foams

New brochure is a pictorial progress report and fact file on industrial and commercial applications for urethane foams. Booklet traces the development of urethane foams from early days of fabrication to the present multiplicity of end-use functions. Number of special industrial categories are treated separately in the illustrated text. Property and performance data relating to various fields of use are presented for practical reference at the material-specifying level. 24 pages. Mobay Chemical Co., Penn Lincoln Parkway West, Pittsburgh 5, Pa.

Circle 720 on Page 19

High Capacity

PORTABLE BRONZE VALVES

Cut Your Valve Costs

Consolidated Portable Bronze Safety Valves are designed specifically for package type steam generators and fire tube boilers. They enable you to design this type of equipment more economically.

High capacity is designed into each valve. Where a valve of lower capacity is adequate, medium capacity valves *of the same size* can be used with the assurance that the valves will always conform to actual requirements. Both initial costs and maintenance costs are held to a minimum.

You are sure of stable performance and uniform blowdown control in Consolidated Portable Bronze Safety Valves. Opening is sharp and clean, without simmer. The seat is machine lapped optically flat to assure positive tightness.

Design for savings from the start. Choose Consolidated Portable Bronze Safety Valves. Be certain of fine operation and long service life, free of costly maintenance. Complete specification data are available in Bulletin 740. Write for a copy.

Consolidated Safety Valve Type 1540 Series. Sizes: ½" through 2½". Pressures to 250 psi. Temperatures to 406° F. Available with side or top outlet, medium or high capacity.

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A product of
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Valve Division • Stratford, Connecticut • In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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Send me your Bulletin 740 which tells all about Consolidated Portable Bronze Safety Valves.

Name_____
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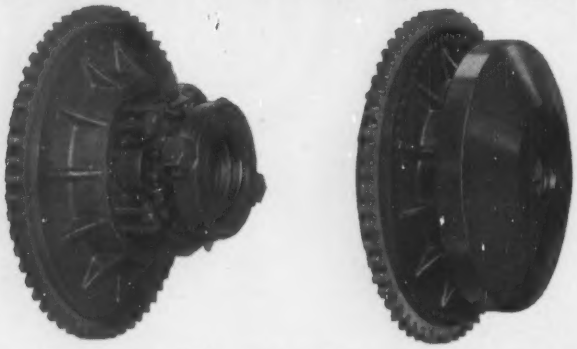
Make Your Choice Of Clutch While Your Equipment Is In The Design Stage . . .



You can have your machine equipped with either our Over-Center Friction Clutch (left) or our Air-Operated Clutch (right). Each has its advantages depending on the use of the equipment. These clutches come in a wide range of sizes and with gear tooth or Flex-Disc. All are high quality, dependable clutches having low power losses, low upkeep, and long life. Readily adjustable for lining wear. Send for bulletins 5009 (Over-Center), 5011 (Air-Operated), or 5012 briefing our entire line of industrial clutches.

INDUSTRIAL CLUTCH CORP.
Waukesha Wisconsin

Circle 546 on Page 19

Wolverine TOGGLE CLAMPS
Cost Less per Thousand Clamping Operations

Note These Important Features:

- HARDENED PINS and BUSHINGS
- HEAVY BODY SECTIONS
- BLACK OXIDE FINISH
- PINS RIVETED FLUSH
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Many Types to Satisfy Your Work Holding Needs

8 STANDARD ACTION UNITS
10 QUICK ACTION UNITS
12 PUSH ACTION UNITS & others

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1482 E. WOODBRIDGE
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Circle 547 on Page 19

HELPFUL LITERATURE

Gyros

"Technical Information for the Engineer—Gyros," in addition to theoretical considerations of gyroscopic instruments, also details performance, application, construction, and testing of such instruments as rate gyros, free gyros, vertical gyros, stable platforms, and accelerometers. Informative edition contains diagrams, equations, charts, graphs, tables, and photographs which illustrate clearly the topics discussed. 44 pages. Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 721 on Page 19

Lock Nuts

Up-dated review of Flexloc self-locking standard nuts and clinch nuts is presented in Form 2339. Complete specification information is included for both light and heavy-duty thin and full-height lock nuts, and also for other types. Application information consists of brief discussions of tensile strengths, reusability factors, and torque uniformity, as well as generalized suggestions on areas of usage for the various types. Self-locking principle is illustrated and explained. 6 pages. Standard Pressed Steel Co., Box 102, Jenkintown, Pa.

Circle 722 on Page 19

Lubricating Units

"The ABC of Modern Lubrication" describes and illustrates the three basic elements of automatic lubrication—lubricators, distribution systems, and meter units. Eight types of automatic lubricators are shown, and distribution system details, including information on the variety of tubing, junctions, and flexible hoses, are given. Third section describes meter unit which regulates the amount of oil flow at each bearing. Cutaway view shows internal construction. 4 pages. Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

Circle 723 on Page 19

Miniature Differentials

Data Sheets 2001 and 3001 cover solid-shaft and hollow-shaft differentials, respectively. Design features are pointed out, including guaranteed backlash rating of 5 minutes maximum, and dimensions and engineering specifications are provided. 2 pages each sheet. Empire Flight Components Inc., Merrick Road, Bellmore, L. I., N. Y.

Circle 724 on Page 19

Industrial Switches

Form 84-441, "Switches for Industry," features an adjustable-pulse switch, center-neutral limit switch, and proximity switch. In addition, a wide variety of limit, explosion-proof, basic, pushbutton, mercury, and toggle switches for use on machine tools and other industrial equipment are illustrated and described briefly. 4 pages. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 725 on Page 19

Typical steam forging hammer

REQUIRED SAFETY FACTORS in steering arm assured by designing it to be forged

By designing with forgings, a truck manufacturer can count on the required safety factors, with minimum "beefing-up" of parts to offset unknown internal structures or non-homogenious materials.

You, too, can achieve results like these by designing *with forgings* either at the start or on re-design. The benefits of forgings are equally impressive, whether you make home-workshop equipment or diesel engines.

Forgings start as *better* metal . . . are further *improved* by the hammer-blows or high pressure of the forging process.

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EVERY TYPE OF KEYING AND PINNING DEVICE FOR PRODUCTION ASSEMBLING · PIVOTS · BUSHES · TENSION, TAPER, GROOVE & DOWEL PINS · MACHINE KEYS & PARTS

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Circle 549 on Page 19

HELPFUL LITERATURE

Computer Characteristics

Pocket-sized catalog contains a chart which includes important features of 43 general-purpose, stored-program electronic digital computers. Units are listed in order of decreasing rental to bring systems of comparable size together. Information includes general characteristics, internal speed, magnetic tape, peripheral equipment, and special features. Charles W. Adams Associates Inc., 142 The Great Road, Bedford, Mass.

Circle 726 on Page 19

Ball Bearings

Catalog 332 presents information on ball bearings for automotive, industrial, aircraft, and military applications. Made to ABEC Class 1 specifications, bearings feature one-piece nylon retainers. Tables and dimensional drawings provide all engineering data for the various types of bearings. Booklet also includes information on rear-wheel bearings, ball-bearing clutch release, self-aligning pillow block, water-pump bearings, and conveyor trolleys. 16 pages. Green Ball Bearing Co., 9518 Cassius Ave., Cleveland 5, Ohio.

Circle 727 on Page 19

Indicator Lights

Catalog 120 features over 30 basic styles of indicator lights, giving engineering data and specifications. Many actual-size photographs and tables are included, and engineering drawings are used to provide specifications and dimensional information. 12 pages. Control Switch Div., Controls Co. of America, 1420 Delmar Drive, Folcroft, Pa.

Circle 728 on Page 19

Rotary Union

Bulletin 700 describes all-purpose, ball-bearing rotary union. Various types are shown, and information includes typical installations, tables of size and dimensions, and engineering specifications. Many photographs are used to describe the union and demonstrate its use in actual applications. Perfecting Service Co., 332 Atando Ave., Charlotte 6, N. C.

Circle 729 on Page 19

Medium-Duty Casters

Form 59-D provides information on Series 16 casters for industrial or institutional use. Units are illustrated, and special features are pointed out. Table provides all size and dimensional specifications. 2 pages. Albion Industries Inc., Albion, Mich.

Circle 730 on Page 19

Pump Manual

Engineering Manual 611 contains much indexed information pertinent to pump selection, installation, and application. Many charts, graphs, and tables are included to supplement the text. 40 pages. Marlow Pumps Div., Bell & Gossett Co., P. O. Box 200, Midland Park, N. J.

Circle 731 on Page 19

HANNIFIN
has a faster, more rugged
AIR MOTOR

Truly a convenience package, the Hannifin Air Motor combines a rugged, low-friction, double-acting air cylinder with a solenoid valve. Ample air passages permit rapid cycling. Built-in speed controls make it possible to slow either or both strokes. Mounting dimensions interchange with most existing applications. "Off shelf" delivery in "standard" strokes. Bulletin 215—free on request—describes this new product.

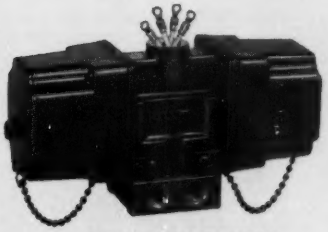
PARKER HANNIFIN CORPORATION
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
HANNIFIN COMPANY
A DIVISION
515 South Wolf Road
Des Plaines, Illinois

3155-PH

Circle 550 on Page 19

SAVE TIME, AIR, MONEY

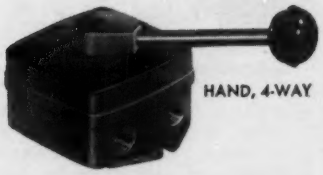
with PARKER-HANNIFIN One-Source Engineering



DUAL SOLENOID, 4-WAY

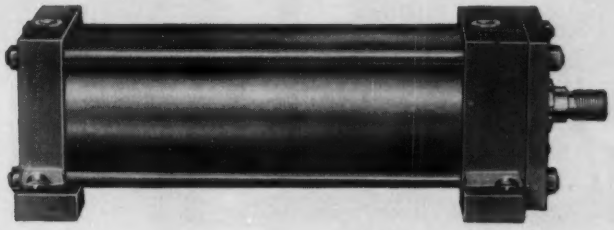
CAM, 3-WAY

PRESSURE, 3-WAY

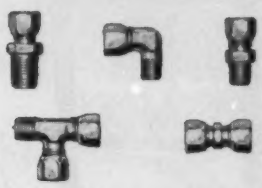


HAND, 4-WAY

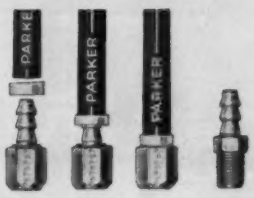
Use flow factors as money-savers—your Parker-Hannifin man can show you how. They help you to avoid "oversizing" your valves. Hannifin's new Valve Finder gives "C_v" ratings for every valve in the line, makes it possible for you to take full advantage of the extra air-flow capacity in Hannifin air valves. Get your copy today.



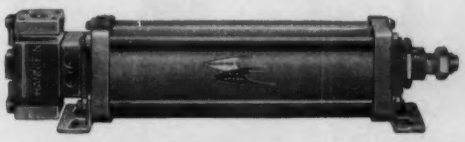
Low friction, long packing life are money-saving features of the Hannifin Series "A" pneumatic cylinder, available in a full range of mounting styles and from 1½" to 14" bore, strokes to 20 feet. Hannifin cylinder application data and charts make selecting the right Series "A" cylinder easy. Get yours from your Parker-Hannifin man.



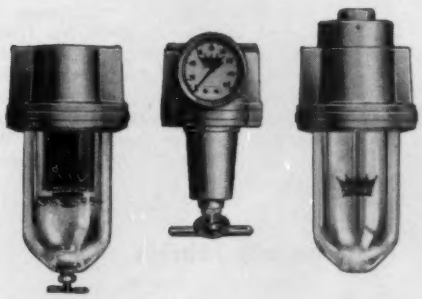
Pneumatic systems tube up fast with Parker "Intru-lok" tube fittings. Use them with copper, nylon or "Parker-POL" polyethylene tubing. Just insert the tube and tighten the nut for a leakproof "bite-type" joint.



Another time-saver is "Push-lok", the Parker hose-and-hose-fittings combination for pressures to 250 psi. No tools needed. Just push this hose on these hose fittings. They won't blow off, ever, not at twice 250 psi.



One air line conection installs the Hannifin Air Motor... an integral solenoid valve controlling a fast, rugged double-acting air cylinder. Built-in speed controls adjust piston speed in either or both directions.



You will save both air and money with Hannifin "Crown" air line filters, pressure regulators and lubricators. Let your Parker-Hannifin man show you how they pay for themselves by making it possible to get all the air flow you need at the exact pressure that will best do the job. "Crown" filters and lubricators will bring further savings through reduced equipment maintenance.

Your pneumatic system shapes up faster at the design stage when one man can discuss with you every component you'll need. But have you realized how much your Parker-Hannifin man can save you in money and air?

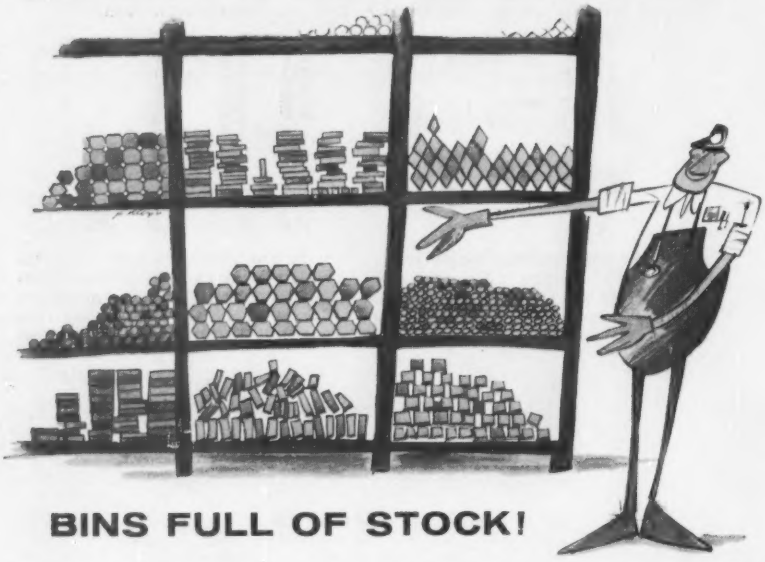
Just for instance... your valves don't have to be ¾" just because the cylinder size you select comes with ¾" ports. Your Parker-Hannifin man chooses valve types and sizes to suit the air flow you'll need. He'll show you, too, how pressure control saves money and air, how a smaller lubricator is often a more efficient lubricator, and other money saving ideas. Then he'll show you ways to "tube up" and "hose up" a leakproof pneumatic system quicker, neater and at lower cost.

Call your nearest Parker-Hannifin sales office, or write direct for complete information.

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
HANNIFIN COMPANY
A DIVISION
515 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3139-PH

BEANS FULL OF KNOWLEDGE...



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If you use alloy steels in your operations, you will find Wheelock, Lovejoy a most useful ally. W-L offers you complete servicing of your alloy steel needs. There are seven strategically-located W-L warehouses, each of which is fully staffed by veteran metallurgists, ready to give you expert advice as to grades, applications, heat treating, etc.

Each W-L warehouse maintains complete stocks of alloy steels, including standard AISI and SAE steels, and our own HY-TEN steels, which offer advanced metallurgical features at competitive prices.

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For service that's complete, and completely satisfactory, call the W-L branch nearest you.

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AGENTS – Southern Engineering Company, Charlotte, N. C.; Sanderson-Newbould, Ltd., Montreal & Toronto

"The Alloy Steel Center"

WHEELOCK, LOVEJOY & COMPANY, INC.

134 Sidney St., Cambridge 39, Mass.

STEEL SERVICE CENTER INSTITUTE

Direct-Writing Recorders

Catalog Sheet 2500 is a three-color, illustrated brochure which describes Mark II portable direct-writing recorders, including both electric and ink-writing types. Brochure discusses the choice of either ink or electric writing for specific applications, and types of data that can be recorded on the four channels of the systems. Features are pointed out, list of operating data and front-panel controls is given, and an adapter for rack mounting is illustrated. 4 pages. Brush Instruments Div., Clevite Corp., 37th & Perkins, Cleveland 14, Ohio.

Circle 732 on Page 19

Steel Analyses

Bulletin T456 provides analyses of standard carbon, alloy, and stainless steels for tubing and pipe for corrosion-resistant service of elevated-temperature and/or pressure service. Analyses are given for about 75 types of steels. List of ASTM specification titles is given. 4 pages. Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 733 on Page 19

Spirally Cabled Tubes

Technical Bulletin 960 gives complete information on spirally cabled tubes for instrument and control systems. Complete detail is given on various types of tubing, the protective, interlocked metallic armor, types of corrosion-resistant sheaths, and instructions for installation. 12 pages. Crescent Insulated Wire & Cable Co. Inc., Trenton 5, N. J.

Circle 734 on Page 19

Measuring Systems

Application notes describing how to assemble systems for precision measurement of pressures, forces, and temperatures are contained in Systems Engineer's Handbook. Material also includes determination of ratios, summations, integrals, mass flow rates, and center-of-gravity. Specifications of compatible FM-system building-block components are also given. 44 pages. Wiancko Engineering Co., 255 N. Halstead, Pasadena, Calif.

Circle 735 on Page 19

Proximity Switches

Form EDPS-80 provides a complete description of entire proximity switch line, as well as basic technical information to enable a prospective user to determine the model best suited to his needs. Illustrated brochure features a control amplifier selection guide, which facilitates matching of control amplifiers with specific applications. New economy proximity switch is fully described. Response curves, mounting drawings, photographs, tabulated descriptive information, and five-step checklist help in the selection of the correct proximity sensing head. 8 pages. Electro Products Laboratories Inc., 4501 Ravenswood Ave., Chicago 40, Ill.

Circle 736 on Page 19

Circle 552 on Page 19

Photo Courtesy of the Pierce Wrapping Machine Company, La Grange, Illinois

STROBOTAC *for Design Analysis*

Type 1531-A Strobotac® Electronic Tachometer and Motion Analyzer . . . $260.

U. S. Patent Numbers: 2,478,901; 2,478,907; and 2,492,142 Patent Pending; Patent Applied For. Licensed under designs, patents and patent applications of Edgerton, Germeshausen and Grier.

This toroidal winding machine for the spiral wrapping of tires, steel coils, rugs, and other products was designed with the aid of the Strobotac. Only under stroboscopic light could the intricate behavior of the wrapping mechanism be studied as the paper was being wound.

In the design of machinery of this type there is no better way to determine whether the various machine parts are operating as planned than to watch the progress in "slow motion" under stroboscopic light. The Strobotac's high-intensity light flashes of a few microseconds duration reveal flaws or machine eccentricities as no other equipment can. The Strobotac also serves as a handy device for speed measurements to 250,000 rpm and above.

Strobotac features which Pierce Wrapping's Chief Engineer indicates are advantageous in his work include:

"The high-intensity white light enables measurements to be made under normal plant lighting, eliminating the need for a previously used darkened room."

"Greater stability of the new Strobotac eliminates the necessity of continuously jiggling the dial to keep the machine synchronized."

"Simplified dial and range-switch arrangement for easy reading."

"The multi-position reflector and lamp can be easily moved around and pointed to best advantage at the inside of the machine without the necessity of repositioning the entire instrument."

"The very well-designed case allows you to close up the unit at a moment's notice and leave it in the shop, while you go back to Engineering to do a little calculating."

CHECK THESE SPECIFICATIONS and see how the new Strobotac will aid you in design and analysis of machine operations — whether it be rotating, reciprocating, or any type of cyclic movement.

Intense, white-light — more than 70 times brighter than previous model.

Extremely short duration flash (1 to 3 μsec) practically eliminates blur — "freezes" motion — shows details heretofore impossible to see.

Measures speed directly with ±1% accuracy to 25,000 rpm — useful to at least 250,000 rpm.

Long-throw beam reaches into the heart of complex machinery — made possible by new flash tube developed exclusively for this instrument.

GENERAL RADIO COMPANY

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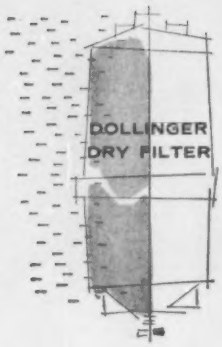
Circle 553 on Page 19



SPECIALISTS
FOR 39 YEARS

LOW COST, EFFECTIVE REMOVAL OF DIRT, PIPE SCALE

Filters for compressed air lines

Staynew Model CPHB-5D Filter has die cast aluminum base and head held together with single bolt, washer, and gasket.

DOLLINGER STAYNEW FILTERS for compressed air lines combine low cost and top filtering efficiency with a compact, easy-to-work-with design. They are small (5¼" high, 4½" diameter) for convenient handling and installation . . . can be opened for inspection and cleaning by simply removing one bolt. Staynew Model CPHB-5D Filters have been designed for 125 p.s.i. with a capacity of 600 SCFH, initial pressure drop of 1 inch of water. They are available in ¾" and 1" female inlet and outlet connections. Discuss Staynew Compressed Air Filters with the Dollinger representative in your area. Or, write for Data Sheet CPHB-5D. Dollinger Corporation, 26 Centre Park, Rochester 3, New York.

PROTECTOMOTOR
STAYNEW
FILTERS

DOLLINGER

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS • HIGH PRESSURE FILTERS AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

Circle 554 on Page 19

Filter Assemblies

Complete data sheets describe over 225 items of 20 basic types of standard woven-wire-mesh element-in-line filters. In addition to the list of standard units, literature describes options which make possible hundreds of additional items. Each of the data sheets shows a cross-sectional view of the filter element and housing. Working pressure, temperature ranges, port sizes, and other significant factors are listed for each type. 20 pages. Aircraft Porous Media Inc., 30 Sea Cliff Ave., Glen Cove, N. Y.

Circle 737 on Page 19

Test Instruments

Short Catalog ES-9 lists complete line of integrated instruments for automatic measurement of sound, vibration, and strain. All units are pictured and described in the 8¼ x 6-in. catalog. 24 pages. B & K Instruments Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 738 on Page 19

Flow Meter

Minirator, a compact, inexpensive flowmeter designed for the measurement of low-flow rates of liquids or gases, is fully described and illustrated in two-color bulletin. Dimensional drawings of both 1½-in. and 4-in. scale models, materials of construction, method of mounting, operational limits, capacities, and optional accessories are also given. 2 pages. Fischer & Porter Co., 628 Jacksonville Rd., Warminster, Pa.

Circle 739 on Page 19

Fluid Systems

Industrial Catalog 250 provides complete dimensional and functional data on all types of hoses, fittings, adapters, and self-sealing couplings for general industrial uses. All specifications, such as pressures, temperatures, and bend radii are included, using cross-sectional photographs, tables, test, and graphs. Hose assembly and installation instructions are also provided, along with specifications on both hand and power assembly of hoses. 140 pages. Write on company letterhead to Aeroquip Corp., Jackson, Mich.

Electronic Equipment

New 1961 catalog of electronic equipment places special emphasis on electronic equipment for industry. It lists over 48,000 items and includes 240 pages in color. Extensive listings of parts and equipment for industrial maintenance, research, and production requirements are included. Also incorporated are a large section on high-fidelity equipment, special selection of stereophonic records and tapes, line of over 60 electronic kits, and a complete technical book section which includes leading publications covering all phases of radio, electronics, and electricity. 576 pages. Write on company letterhead to Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle 555 on Page 19→

LONG LIFE, *THOMSON* "Snap-In"

NYLINERS®

—BEARINGS of smooth, tough DuPont NYLON

Low Cost FLANGED Nyliner | Low Cost SLEEVE Nyliner | Low Cost DOUBLE-FLANGE Nyliner

COST LESS to BUY
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& ELIMINATE LUBRICATION

Additional Benefits:

- CLOSE FIT
- LONGER LIFE
- EASILY INSTALLED
- LESS SERVICING
- SELF-RETAINING
- RESIST CORROSION
- LOW FRICTION
- RESIST POUNDOUT
- NO FRICTION OXIDATION
- DAMP VIBRATION
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- INSTANTLY REPLACEABLE
- RESIST ABRASION
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NYLINER Bearings are a highly engineered thin liner of DuPont Nylon, designed to bring bearing users the many benefits of Nylon as a bearing material by solving most of the limitations surrounding its use. The compensation gap principle assures maintenance of diametral tolerances for precision applications.

Seven Standard Types available from stock. Write for literature and name of your local representative who stocks NYLINER Bearings for immediate shipment.

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Also— —Manufacturers of BALL BUSHINGS . . . the Ball Bearing for Linear Motions and 60 CASE . . . Hardened & Ground Steel Shafting

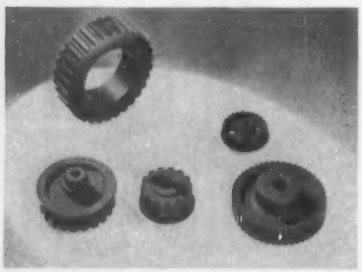
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Timing-Belt Pulleys

of glass-filled nylon or high-impact styrene

Timing-belt pulleys and power transmission parts use glass-filled nylon or high-impact, glass-filled styrene. A third material used is glass-filled nylon with 4 per cent molydisulfide. Long belt life and quiet operation of a pulley are provided by use of these materials, due to low frictional properties. Nonmetallic pulleys can be operated as self-lubricating type



bearings. Pulleys offer high degree of dimensional stability as required in timing-belt applications such as in cameras, business machines, computers, and airborne equipment. Wide range of configurations is available. **Gibson-Egan Co.**, P. O. Box 5352, Pasadena, Calif.

Circle 740 on Page 19

Control Valves

for ¼-in. OD tube size

Fingertip control valves with Swagelok connections are for ¼-in. OD tube size. Valves, in brass and type-316 stainless steel, are available in straight and angle-pattern styles. No. 1 series valves has a 3000-psi pressure rating with 0.172-in. orifice diam. Forged-body valves have either microregulating or nonregulating stems. Stems are machined from type-316 stainless steel. Teflon cylinder packing and panel-mounting nuts are standard with each

valve. All valves are supplied with a choice of colored handles. **Whitey Research Tool Co.**, 5525 Marshall St., Oakland 8, Calif.

Circle 741 on Page 19

Insulating System

for high-performance electronic equipment

Two-component, liquid-epoxy insulating system for high-performance electrical-electronic equipment meets requirements of MIL-I-16923C, Types B, C, and D. It is outstanding in its balanced electrical, thermal, and physical properties. **Electrical Insulation Div., Hysol Corp.**, Olean, N. Y.

Circle 742 on Page 19

Overrunning Couplings

in ⅛ to 1-in. shaft sizes

New couplings are suitable for overrunning, backstopping, and indexing applications. Driving element is

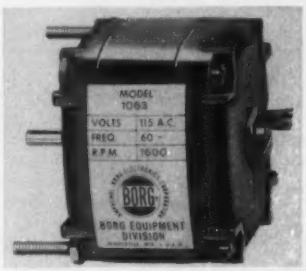
a rectangular-section steel spring which insures maximum driving surface and low contact pressure during overrunning. Clutches have plastic lock-type set screws. Sizes range from ⅛ to 1-in. shaft size. **International Mechanisms**, Box 25, Fairport, N. Y.

Circle 743 on Page 19

Instrument Motors

are low-inertia, subfractional-horsepower units

Series 1060 instrument motors are designed for installation where exceptionally rugged and reliable control motors are demanded. The low-inertia, subfractional - horsepower motors are furnished for single-phase, 115-v, 60-cycle operation. Extended rotor bearing preload adjustments are provided for minimum starting voltage control. Two basic designs are available, with gear



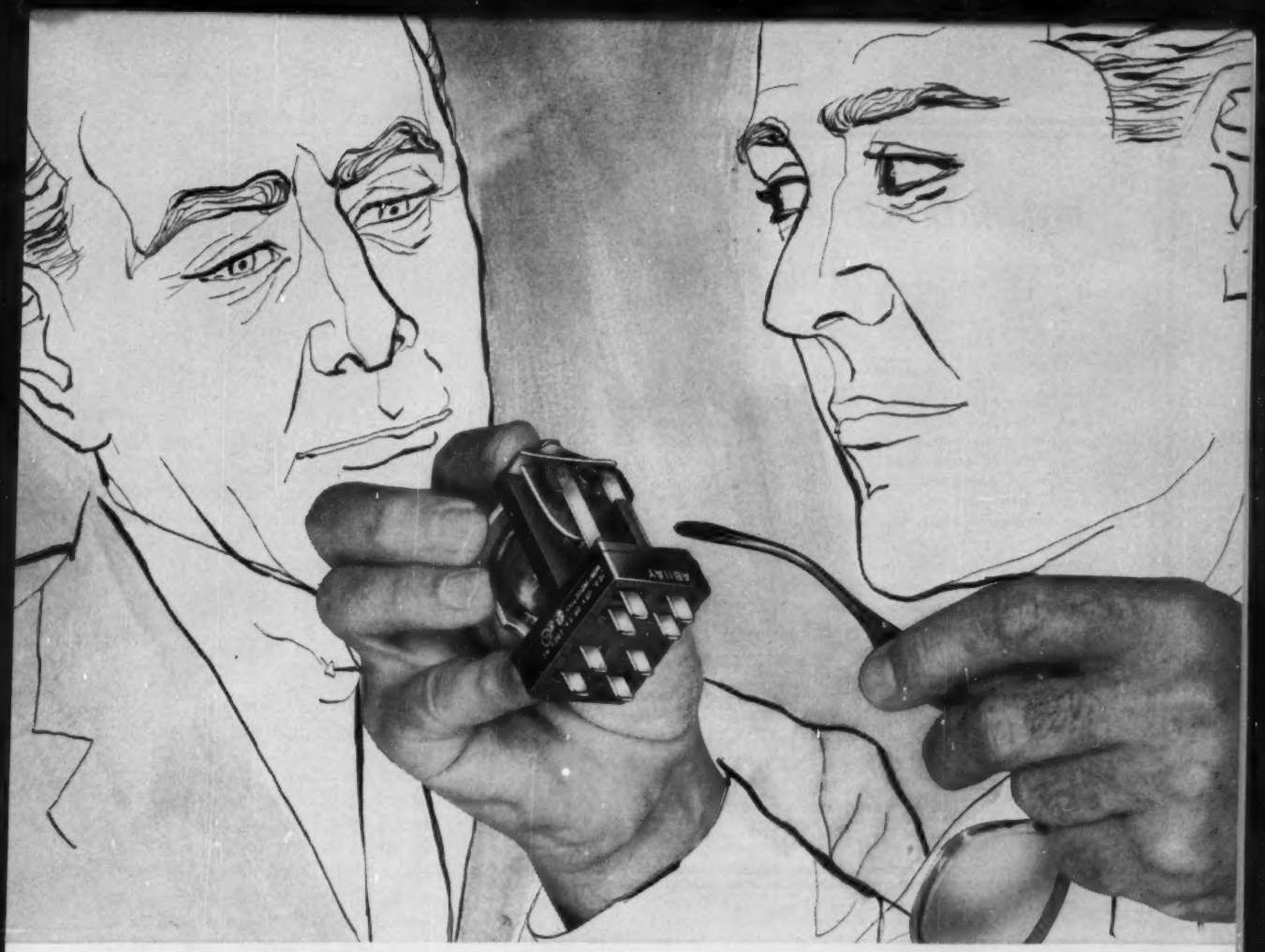
trains optional on each, making a total of four available models. **Borg Equipment Div., Amphenol-Borg Electronics Corp.**, 120 S. Main St., Janesville, Wis.

Circle 744 on Page 19

Compression Nuts

are made by impact extrusion

Compression nuts, manufactured by the impact extrusion process and threaded, are available in aluminum, brass, steel, and stainless steel. All



appearances are not deceiving

THIS P&B 10-AMP RELAY IS AS RELIABLE AS IT LOOKS

Our AB relay looks rugged . . . and it is. You can specify it for 10 amp switching and confidently expect 100,000 cycles. Yet it is compact, easily mounted, and does not require special handling. Installation is simple, using your preference of screw terminals (adapters), quick connects, or dip soldering.

Designers specify the AB for air conditioners and other products where dependable, continual service is paramount.

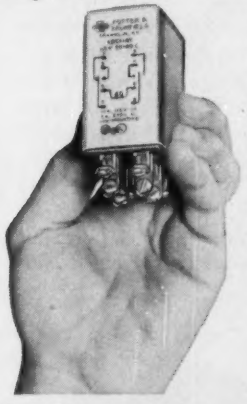
These standard AB and ABC relays are listed by Underwriters' Laboratories and Canadian Standards Association:

Type	Arrangements	Type	Arrangements
AB7AY	DPST-NO	ABC7AY	DPST-NO
AB8AY	DPST-NC	ABC8AY	DPST-NC
AB11AY	DPDT	ABC11AY	DPDT

Coil voltages: 6, 12, 24, 115 and 230 volts AC, 50/60 cycle.
Contact rating 10 amps. 115 volts AC or 5 amps, 230 volts AC noninductive.

U/L File E-29244 CSA No. 15734

Write for complete data or contact your nearest P&B sales engineer.



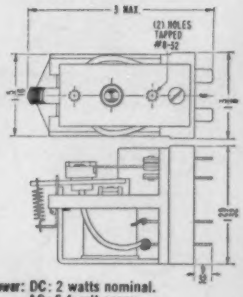
ABC Series—AB series can be supplied enclosed in sturdy metal dust cover, 1 31/64" x 2 29/32" x 2 5/32".

AB AND ABC RELAYS ENGINEERING DATA

GENERAL:
Insulation Resistance: 100 megohms minimum.
Life: 3 million cycles (mechanical).
Breakdown Voltage: 1500 volts rms between all elements and ground.
Temperature Range: DC: −55 to +45°C.
AC: −55 to +45°C.
Weight: AB—5 ozs. ABC—7 ozs.
Terminals: Fit ¼" quick-connect terminals, or may be applied to printed circuits using dip soldering. Screw adapters furnished on request.
Enclosure: ABC: Heavy duty dust cover.
Dimensions: 1 31/64" x 2 29/32" x 2 5/32".

CONTACTS:
Arrangements: DPDT
Material: ¼" dia. silver. Other materials available.
Load: 5 amps at 230 volts AC or 10 amps at 115 volts AC noninductive.
10 amps at 28 volts DC.

COIL:
Voltage: DC: 6 to 110 volts.
AC: 6 to 230 volts.



Power: DC: 2 watts nominal.
AC: 6.4 volt-amps.
Resistance: 35,000 ohms max.
Duty: Continuous: DC coils will withstand 6 watts at +25°C.

MOUNTINGS:
AB: Two 8-32 tapped holes on 1¼" centers.
ABC: One 8-32 stud ⅜" long and locating tab.

P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

Circle 556 on Page 19

What makes the first gear-type coupling still first choice?

Check design . . . and you'll find Fast's Couplings (the original gear-type couplings) are superbly engineered, ruggedly built, smoothly running units designed to outlast the machines they connect.

Check completeness of line . . . and you'll find Fast's Couplings come in a complete range of sizes and types for shafts from ½" to 32" and larger.

Check service . . . and you'll find Fast's Couplings are backed by expert help from experienced field engineers . . . while outstanding stock facilities throughout the country insure speedy delivery of your coupling orders.

Check popularity . . . and you'll find Fast's Couplings are the choice of more industrial equipment manufacturers than any other shaft coupling.

Check Fast's for your coupling needs today.

KOPPERS COMPANY, INC., 411 Scott St., Baltimore 3, Md.

KOPPERS

FAST'S COUPLINGS

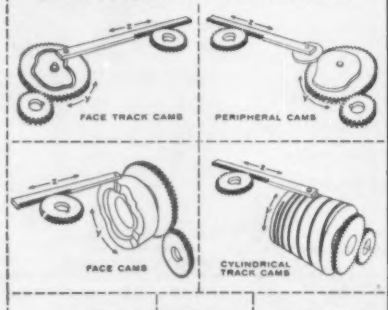
Engineered Products Sold with Service

Circle 557 on Page 19

CAMS

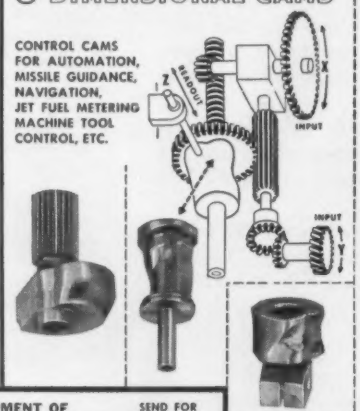
✓ 2 & 3 DIMENSIONAL MASTER CAMS
✓ EXPERIMENTAL CAMS
✓ PRODUCTION CAMS

2 DIMENSIONAL CAMS



3 DIMENSIONAL CAMS

CONTROL CAMS FOR AUTOMATION, MISSILE GUIDANCE, NAVIGATION, JET FUEL METERING MACHINE TOOL CONTROL, ETC.



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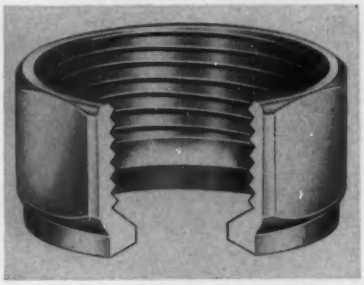
Circle 558 on Page 19



finishes are furnished in a full range of commercial sizes. Nuts are of high quality, and are priced lower than nuts made by conventional methods. **Jacobson Nut Mfg. Corp.**, Box 177, Kenilworth, N. J.

Circle 745 on Page 19

Molded Parts

of reinforced Viton molding compounds

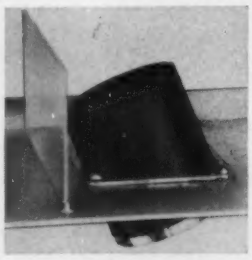
Viton molding compounds reinforced with asbestos, glass, or ceramic fibers are supplied only in finished molded form. Configurations range from large O-rings to small lip-type seals, intended primarily for gasketing and sealing applications involving immersion in organic chemicals and hydraulic fluids at high temperatures. **Rogers Corp.**, Rogers, Conn.

Circle 746 on Page 19

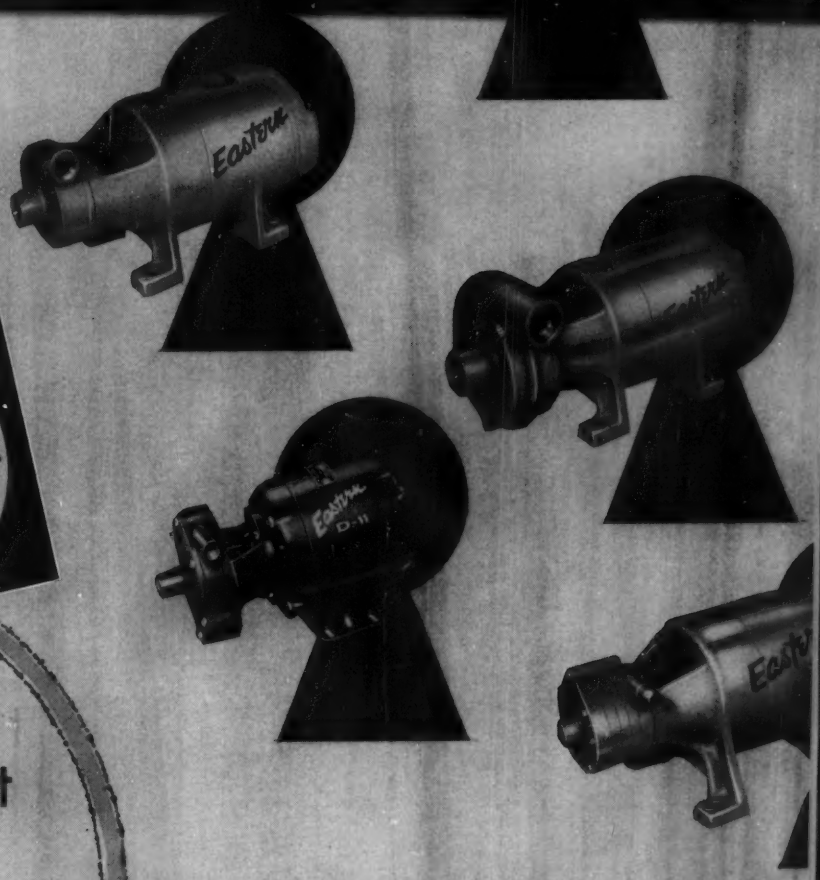
Blower Assembly

has removable motor for easy field service

Powair 2-in. blower incorporates a removable motor which is easily slipped out of the blower, permitting simple field servicing. All parts are also interchangeable and available as spares. Unit provides 2000-hr life at 22,000 rpm. The 400-cycle motors of the blowers are stainless steel, and bearings larger in diameter than normally found in mo-



Circle 559 on Page 19→



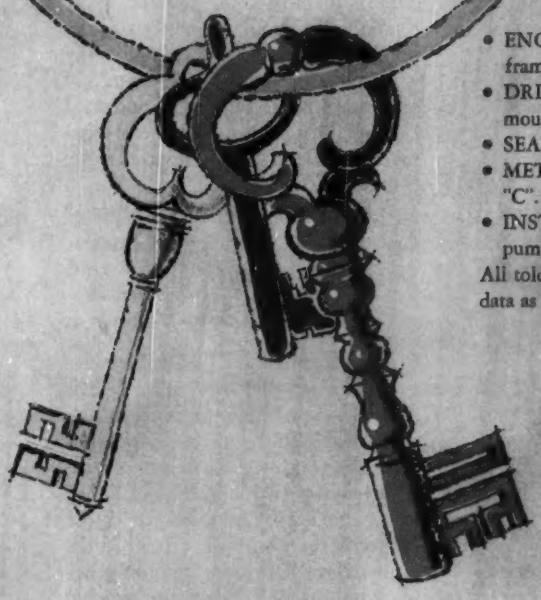
your key to the perfect choice of CENTRIFUGAL PUMPS

A new catalog opens wide the doors to designers of process equipment — tells all you need to know in terms of engineering data, performance charts, seals, metals, mountings!

If you need centrifugal pumps with these characteristics, this reference book is for you:

- PRESSURES: to 21 psi in single stage pumps; to 70 psi in multi-stage types.
- FLOWS: capacities to 70 gpm in single-stage pumps, to 10 gpm for multi-stage models.
- MOTORS: standard motors for 115/230 volts 60 cycles 1 phase (other electrical characteristics available). Power range from ⅛ to 1½ H.P.
- ENCLOSURES: drip-proof, totally enclosed, and explosion-proof ballbearing frames.
- DRIVES: Space-saving close coupled pumps most rugged and popular. Pedestal mounted arrangement without motor available as alternate for belt or coupling drive.
- SEALS: a variety of rotary seals and stuffing boxes, to fit every application.
- METALS: your option of cast iron, bronze, stainless steel, Monel, Cast Iron, Hastelloy "C".
- INSTALLATIONS: a wide range of transfer, recirculation, feed, boost and filter-pumping applications.

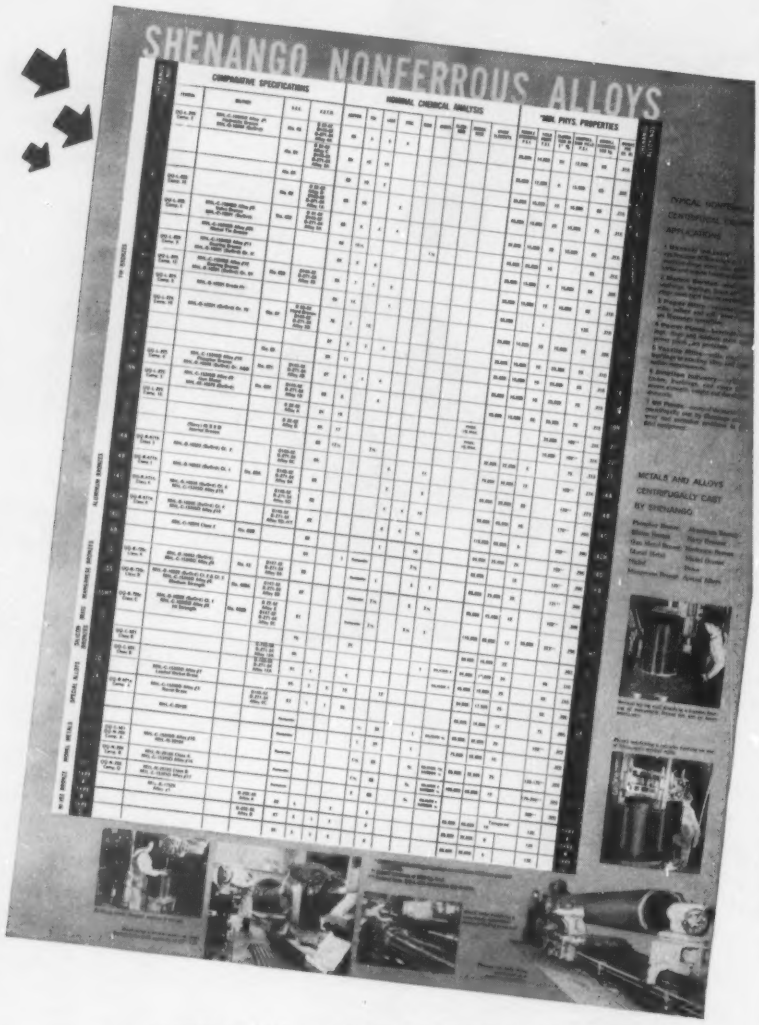
All told, 50 different models are described in full — and you get a wealth of technical data as well. Write for new catalog 130 now!



EASTERN INDUSTRIES ★ PUMP DIVISION ★

EASTERN INDUSTRIES, INCORPORATED

100 SKIFF STREET, HAMDEN, CONN.
WEST COAST OFFICE 4203 Spencer St., Torrance, Calif.



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This invaluable chart of nonferrous alloys centrifugally cast by Shenango is readily available upon request. For your free copy, write to this publication or the Centrifugally Cast Products Division, The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES · ALUMINUM AND MANGANESE BRONZES
MONEL METAL · NI-RESIST · MEEHANITE® METAL · ALLOY IRONS · DUCTILE IRON

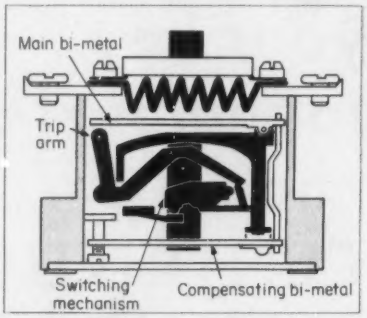
tors of this size are used to assure long life. **Dean & Benson Research Div., Benson Mfg. Co.,** Kansas City 27, Mo.

Circle 747 on Page 19

Overload Relay

compensates automatically for both heat and cold

Ambient-compensated, compact overload relay compensates for both heat and cold, operating on the same time curve at all temperatures from −20 to +165 F. Working bimetal and compensating bimetal, identical in size and construction, are joined by a coupling bar which maintains



identical tripping regardless of temperature. Calibrating screw permits precise setting for the exact current required. Relay uses standard heaters and works equally well with either quick-trip or regular type. Available with all magnetic starters in NEMA Sizes 0 through 5, relay is supplied in ratings from 25 to 300 amp continuous current. **Industrial Control Div., Arrow-Hart & Hegeman Electric Co.,** 103 Hawthorn St., Hartford 6, Conn.

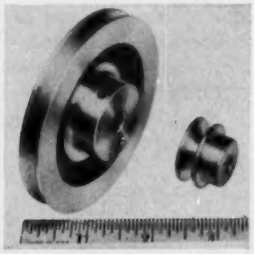
Circle 748 on Page 19

Small-Size Pulleys

for ¼-in. V-belt drives

Precision, small-size QV pulleys are available for 2L (¼ in.) V-belt drives. Designed for use on light machinery and instrument drives, pulleys are produced with groove dimensions to RMA standards. They are compactly designed for space economy in confined areas. Maximum width is ¾ in., including ⅜-in. extended hub. Bores and grooves are completely machined in a single chucking, assuring absolute concen-

Circle 560 on Page 19



tricity and freedom from belt vibration and noise. In addition to use with standard 2L belts, pulleys also can be used with 3/16 and ⅛-in. round belts. Eleven pulley sizes from 1 to 6½-in. OD are available in ½-in. increments. Range of 44 stock bores for the 11 sizes includes ¼, 5/16, ⅜, 7/16, and ½ in. Smallest sizes to 2-in. OD are steel; larger diameters are aluminum alloy, webbed on hub side for light weight. All are furnished with socket set screws. **Climax Metal Products Co.**, 863 E. 140 St., Cleveland 10, Ohio.

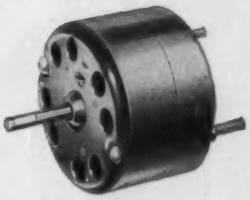
Circle 749 on Page 19

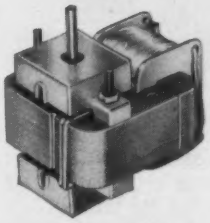
Air Filter

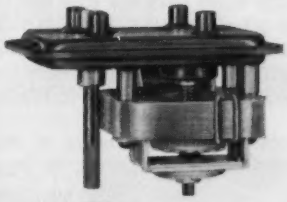
requires no manual draining

Mark ADF automatic-drain air filter is self-cleaning and requires no manual draining. Centrifugal action spins out heavier-than-air solids and a cartridge of two Monel screens filters the air. Cartridge is easily removed for cleaning rust and insoluble gums. Momentary differential pressures above and below a neoprene diaphragm seal a poppet valve with snap action against upper and lower seats. During travel between poppet seats, small amount of air blows out accumulated moisture and solid particles which have previously drained into the sediment bowl. Lower end of unit is threaded ⅛-in. male pipe for at-

...that's why quality and economy go hand-in-hand in famous GI motors







True economy in any manufactured product is achieved by more efficient production, not by the use of cheaper components. In General Industries' plants, we produce practically every component of GI motors except the raw materials. Our self-sufficient, integrated production lines, employing the most modern machinery, permit us to offer you quality and economy unexcelled in the A.C. motor field. Add our 40 years' experience in designing and building motors for every requirement, and you can readily see why leading manufacturers the world over prefer to Specify GI!

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AC MOTORS

1/1800 H.P. TO 1/35 H.P.

Catalog Available on Request

THE GENERAL INDUSTRIES CO.

DEPT. GK • ELYRIA, OHIO

Circle 561 on Page 19

Engineering ingenuity, skilled manufacturing craftsmen, new customer services and "stepped-up" production capacities all combine to bring you the quality components and parts you want when you want them.

Yes, you can depend on Alloy Products Corp. to promptly, efficiently meet all your stainless steel requirements.

Just a postcard brings a quick reply to all your stainless steel requirement questions.

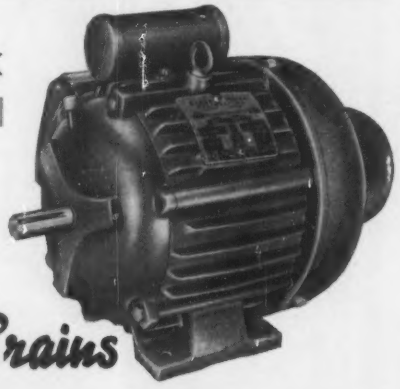
Craftsmen in Stainless Steel SINCE 1929

ALLOY PRODUCTS CORP.

1067 PERKINS AVENUE • WAUKESHA, WISCONSIN

Circle 562 on Page 19

this new Brook totally enclosed fan cooled, single phase motor has



Brawn and Brains

The BRAWN is in the rugged design, producing cool operation and long service life and in the housing, which keeps out dust and moisture . . . and the external fan which blasts cooling air over the heat dissipating fins on the housing.

The BRAIN is in the external centrifugal switch which positively disengages when motor has attained pre-set speed. Switch is on outside of motor for accessibility . . . just remove cap. No need to disassemble the motor or remove it from line for switch repairs. Same switch fits all sizes of motors . . . 1 to 5 HP.

You get real economy where dust, fumes or moisture are a problem. Dealers everywhere. Send for literature.

"World's Most Respected Motor"

BROOK MOTOR CORPORATION

3302-04 W. PETERSON AVE., CHICAGO 45, ILL.

IN CANADA: BROOK ELECTRIC MOTORS OF CANADA, LTD., 250 UNIVERSITY AVENUE, TORONTO

SINCE 1904

BROOK ELECTRIC MOTORS

Circle 563 on Page 19

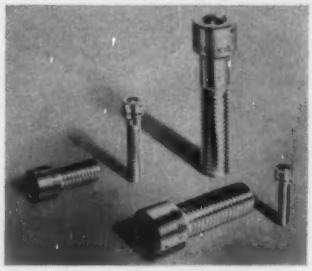
tachment of pipe or hose to drain away condensate. Unit is available in ¼, ⅜, and ½-in. full area pipe sizes. **OEM Equipment,** 19560 Center Ridge Rd., Cleveland 16, Ohio.

Circle 750 on Page 19

Tension Fasteners

for high-strength industrial use

Series K Unbrako tension fasteners, basically socket-head cap screws in configuration and dimensions, have twice the fatigue strength of standard industrial counterparts. Minimum static tensile strength of 160,000 psi is roughly that of standard industrial socket screws, but endurance limit is 40,000 psi as compared to 20,000 psi in standard units. Fasteners are AMS 8740 aircraft-



grade alloy-steel, heat treated to a stress level of 160,000 psi minimum, Rockwell hardness of 36-40. There is no appreciable loss in strength characteristics at temperatures to 550 F. Sizes range from No. 8 through ½ in., fine or coarse threads. They are cadmium plated to QQ-P-416. **Standard Pressed Steel Co.,** Jenkintown, Pa.

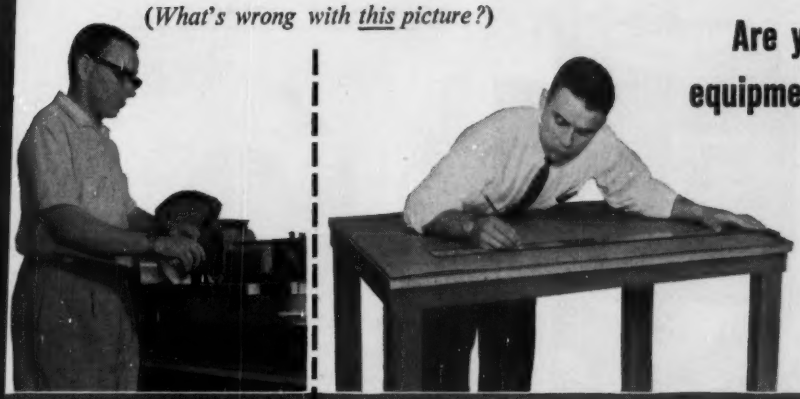
Circle 751 on Page 19

Counting Dial

is connected directly to potentiometer

Precision-built, ten-turn counting dial is a 100-graduation, rotating unit connected directly to the potentiometer by means of a mounting screw. Window ten-turn indicator shows only one numeral, providing high accuracy for rapid readings. Numerals appear with speed and are held in place until the next full rotation of the graduation dial. Dial features a satin finish with large

(What's wrong with this picture?)



Are your mailboys working with better equipment than your engineer-draftsmen?

Your mailroom equipment is expensive—but, because it does essential work, it pays off. However, you may be badly handicapping some of your most *skilled, professional talent*—your drafting men—if they're still working with antiquated, inadequate, uncomfortable equipment.

Your draftsmen, your productivity, deserve new Hamilton space-and-time-saving equipment—from Bruning

For its cost, Hamilton drafting equipment will produce more marked improvement in efficiencies than any other equipment expenditures in your plant.

It steps up productivity—directly and unmistakably—because: (a) construction and design features insure greater accuracy, consistent performance; and (b) anatomy-conscious design greatly reduces fatigue, permits the exact work positions and heights best suited for individual jobs.

Hamilton equipment *continues* to deliver this superior ease and performance, because it is so carefully constructed, of such quality components, that it outlasts ordinary equipment by many years. It *stays* modern, because it totally conforms to individual needs.

Shown here are three of the many products in the complete Hamilton line. Learn about the many other units Hamilton offers. Our expert planning personnel can be of considerable assistance, suggesting the arrangements best for you.

Hamilton De Luxe Auto-Shift Table

You'll get peak productivity and greater work quality from your board men when equipped with the new Auto-Shift. It is considerate of comfort, and delivers wide flexibility of adjustments.

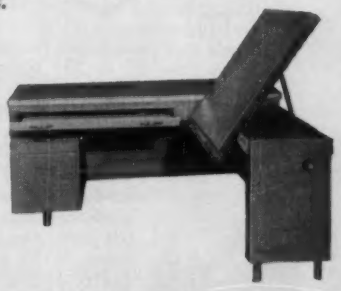
Perfect, fully seasoned drawing surface; front-to-back filing in full-width drawers; stylized leveling legs . . . many more functional and styling features.

Hamilton Interlocking Plan Files

Provide greater protection, accessibility, and classification. Assembly shown includes (top to bottom) 5-drawer unit for semiactive material, 10-drawer section with tracing lifter that makes every sheet as accessible as a top sheet, and two vertical drawer units. Interlocking roll tracing unit also available. Interlocking caps and bases, with latter available for variety of stack heights. Rugged construction, smooth drawer action, trim beauty.

Hamilton L-Contour Table

While occupying very small space, this table provides man-sized, fully comfortable work area. Board fully adjustable from horizontal to vertical. Working surface exceptionally stable, perfectly balanced. Many other features—plus the quality of construction found only in Hamilton equipment.



Put draftsmen in a "position" to do better, faster work!

Bruning's all-new Neoglide drafters literally help draftsmen straighten up and do faster, better work.* They provide complete maneuverability on any board at any angle without adjustment! Reinforced U-beam construction assures rigidity, strength, and accuracy. Resistance-free movement of vertical beam and hidden counterweight provide fast "floating" action.

Touch-control protractor head gives automatic, pinpoint angle selection.

*Study of 300 draftsmen showed 35% savings in drawing time—1/5 the backaches—on vertical or near vertical boards.

BRUNING

CHARLES BRUNING CO., INC.
1800 CENTRAL RD., MT. PROSPECT, ILLINOIS

Circle 564 on Page 19

ALLEN

The cost of ALLEN Hex-Socket Cap Screws is only a minor fraction of your assembly costs . . . be sure you're getting the timesaving, cost-saving advantages of genuine Allens!

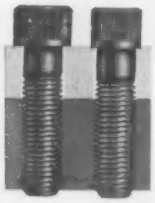
Ever since Allen first produced the hex socket head screw nearly fifty years ago, specifying *genuine* Allens (made by Allen of Hartford) has been a sure way to guarantee dependable threaded fastening.

Only *genuine* Allens have Leader Points that make starting easier, and greatly minimize danger of cross threading. *Genuine* Allens are "pressur-formd" to preserve the long fibers uncut throughout the length of the screw, giving stronger sockets for greater tightening torque.

Write for samples and engineering data. See how *genuine* Allens will make your product better.

ALLEN HEX-SOCKET SCREWS HEAD

Allen's new 1960 Series Socket Head Cap Screws give up to 2½ times more load carrying capacity, without indentation. Head diameter of sizes from ¼" up is now uniformly 1½ times the body diameter—providing more under-the-head bearing surface, and a proportionate increase in clamping force. Write for new Bulletin G-25, with full specifications.



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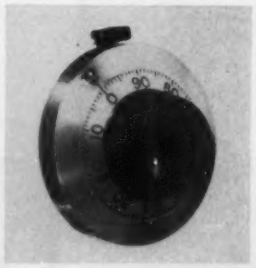
50 ANNIVERSARY YEAR ALLEN HEAD 1910-1960

ALLEN MANUFACTURING COMPANY

HARTFORD 1, CONNECTICUT, U.S.A.



black numbers for easy reading and a black plastic serrated knob. Dial provides smooth continuous operation in either direction, and includes a positive-locking device. Dial is 1 13/16 in. in diam. **S. A. Asquith Co.**, 427 W. Chevy Chase, Glendale 4, Calif.

Circle 752 on Page 19

Conveyor Belt

offers high resistance to cuts and tears

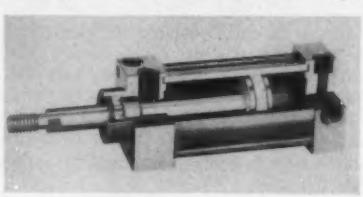
Woven-carcass rubber conveyor belt, called Industrial Uniflo, offers extremely high resistance to cuts and tears. Produced in continuous lengths without cover seams, belt features a carcass of nylon-reinforced cotton yarn, woven into a special interlocking complex. Material has ten times the rip resistance of conventional cotton-duct belts and three times that of best cotton-nylon ply belts of comparable strength. Built-in impact resistance, excellent fastener-holding qualities, outstanding troughing and tracking properties, and better resistance to edge wear are other advantages of the belting. **Conveyor Belt Dept., Goodyear Tire and Rubber Co.**, Akron 16, Ohio.

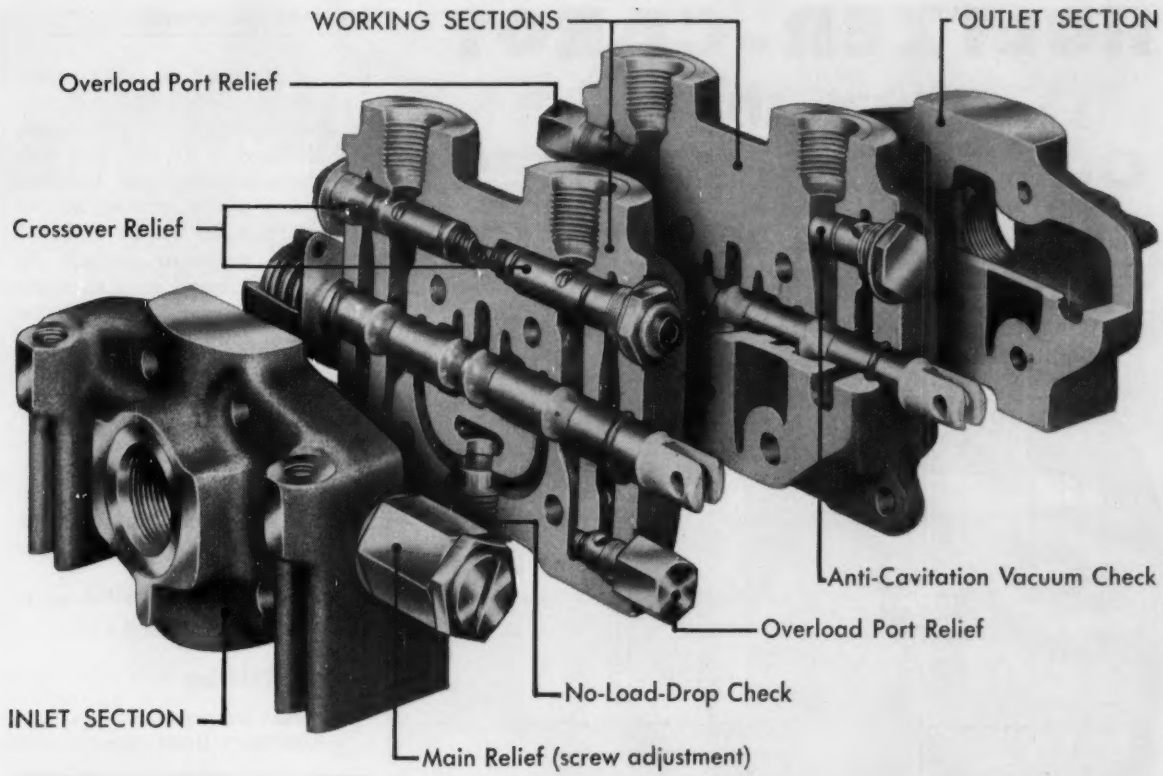
Circle 753 on Page 19

Air Cylinders

for heavy-duty use in small spaces

Series B 1-in. bore air cylinders are designed especially for high-speed assembly machines and other heavy-





Only 12 psi drop in new 2000 psi valve

For earth moving, mining, materials handling, agriculture and ground support equipment

COMMERCIAL Model A, series 20 and 35 manually operated parallel circuit valves directionally control fluid power up to 2000 psi. Internal pressure drop has been reduced at least 50% compared to earlier models. Back pressure in the exploded A20 valve, illustrated, having two working sections, is only 12 psi at 20 gpm through flow—all spools neutral. Under same conditions, valve having six working sections records back pressure of only 33 psi. Performance of the A35 valve is equally outstanding. Complete, all-condition performance ratings are available—proving quite revealing.

Exclusive Easy Access Features

- MAIN RELIEF VALVE controls system relief pressure—circuit loaded
- NO-LOAD-DROP CHECK blocks pressurized return flow
- FLOW RESISTOR CHECK controls rate of cylinder movement
- OVERLOAD PORT RELIEF prevents pressure build-up beyond port—spool neutral
- ANTI-CAVITATION VACUUM CHECK releases vacuum build-up in cylinder
- CROSSOVER RELIEF protects against shock load—spool neutral

Smooth, Precise Operation—COMMERCIAL's new, rugged, heavy-duty valves eliminate jerky, erratic movements of equipment common to ordinary valving. Highly sensitive and positive is their action. Just "velvet touch", finger tip, spool operation meters the most precise and delicate flow. Feel of equipment motion actually "plays back" through the spool handle.

Control Functions for All Needs—Working sections can be assembled in tandem, in any sequence. Sections with 3, 4 or 5 spool positions are available with spring return or detented spool actions. Single acting, double acting, hold, float or regenerative actions are all available. Complete hydraulic system and equipment protection can be yours—built right into Model A valves—without external piping.

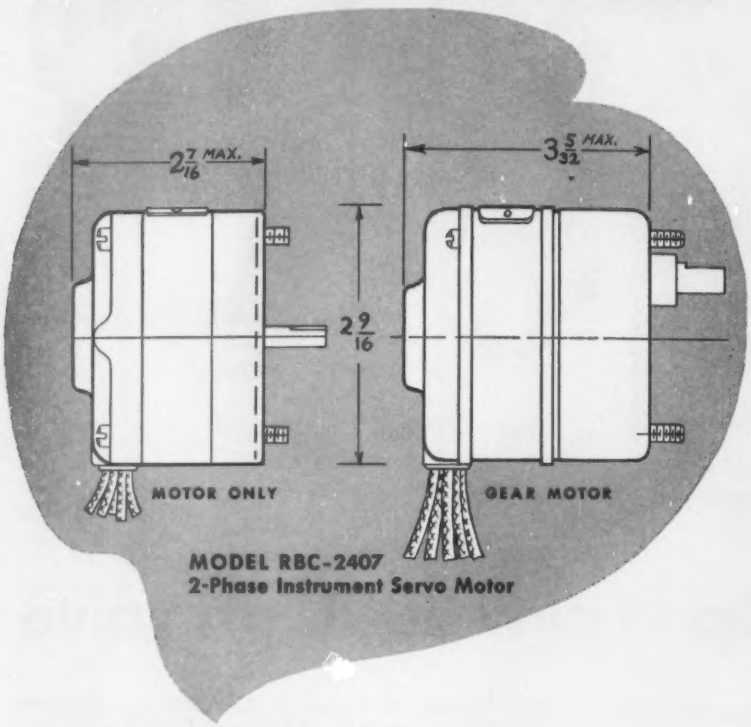
Technical Service and Literature—Experienced technical service and assistance is available from our factory-based personnel. Bulletin 100-P16 gives full data on the new Model A valves. Address: Commercial Shearing & Stamping Company, Dept. S-46, Youngstown 1, Ohio.

pumps, valves, cylinders, motors

COMMERCIAL *shearing & stamping*

Circle 566 on Page 19

HOLTZER-CABOT
offers these CUSTOM FEATURES in a new stock motor



MODEL RBC-2407
2-Phase Instrument Servo Motor

- High torque-to-inertia ratio
- Torque to meet your needs
- Several output speeds to choose from
- Control winding impedance of 5400 ohms locked rotor
- New motor end cap design for easier mounting, better heat dissipation

The RBC-2407 is available as a basic motor or with four stock gear ratios to meet your application requirements. All gear motors are electrically and mechanically interchangeable. Send coupon for free bulletin covering complete details, including physical dimensions and electrical specifications of this Model RBC-2407 instrument motor.

HOLTZER-CABOT MOTOR DIVISION • NATIONAL PNEUMATIC CO., INC.

Sales-Service Representatives in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

HOLTZER-CABOT MOTOR DIVISION, Department MD
National Pneumatic Co., Inc., 125 Amory St., Boston, Mass.

Please send: ☐ Complete details of Model RBC-2407 Servo Motors
☐ Information on other H-C Instrumentation Motors

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

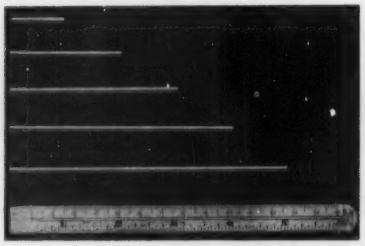
Circle 567 on Page 19

duty applications in small space. Cylinders employ Teflon rod seal-wiper combinations and piston seals, and are rated at 200 psi. Rod seal-wiper combination and leakproof barrel seals can be removed without disassembling the cylinder. Barrel seals are supported radially by shoulders on barrel ends to insure proper seal compression. Piston seals have low coefficient of friction, eliminate stick-slip, and require no lubrication. They are held against the cylinder by O-ring expansions. Eight standard strokes ranging from ½ to 5 in. are available, with front flange, rear flange, trunnion, clevis, or foot mountings. **Hydro-Line Mfg. Co.**, 5600 Pike Rd., Rockford, Ill.

Circle 754 on Page 19

Ground Shafting

has OD tolerance of +0.0000 to −0.0001 in.



Super-precision ground shafting of 303 stainless steel is available in ODs of 0.12475, 0.18725, and 0.24975. Shafting has straightness of 0.0002, 0.00015, and 0.0001 in. per in. respectively. Extreme OD tolerance is +0.0000 to −0.0001 in. Chamfered-type shafting is available in over-all lengths from 1 to 5 in., ±0.010. Surface finish does not exceed RMS-8. **Dynamic Gear Co.**, Dixon Ave., Amityville, N. Y.

Circle 755 on Page 19

Gasoline Carburetor

is one-piece, solid-aluminum unit

Model USX solid-aluminum, one-piece gasoline carburetor for high horsepower farm and industrial equipment meets requirements of modern tractor and industrial engines with increased horsepower, performance, and economy charac-

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By Fred E. Graves

Fastening of "blind hole" joints

Holes which don't go all the way through a solid member must be tapped, of course. In shallow, small holes, in non-critical fastening, and in soft materials thread cutting screws work well and save time.

But fastening large flanges, pressure plates, heads and the like to costly castings needs more precise production. These holes are ¼" diameter and larger, affect design strength.

THREAD EFFECTS

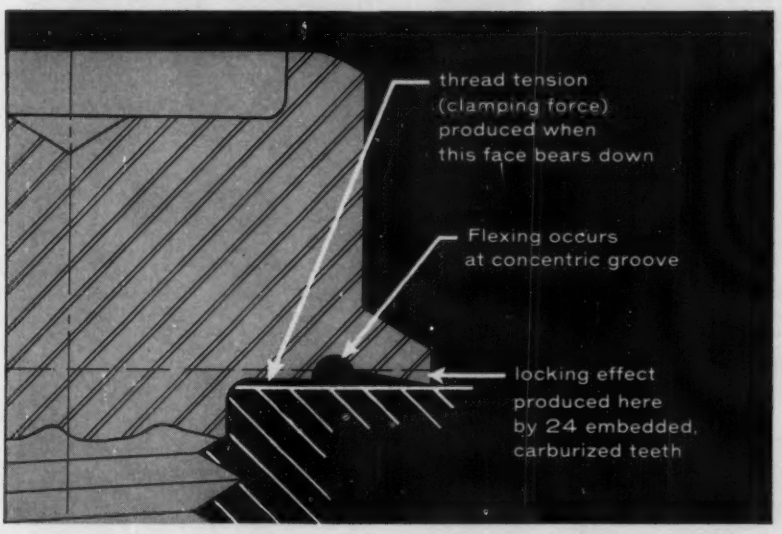
Such holes are coarse threaded. The coarse threads develop more thread strength than do fine threads, also take fewer turns in assembly. Studs go into the holes with an interference thread fit; hex screws with a simpler clearance fit.

Desirably, studs should all be driven to same depth and bottomed. Because of normal manufacturing differences, various mismatched high and low tolerances will cause studs to project unevenly. Assemblers often have to juggle. No such problem exists with hex screws. You just tighten to specified preload. And there's no double driving operation, as with stud plus nut.

STRENGTH OF BLIND JOINTS

Tapped holes behave like nuts. Their threads adjust elastically and plastically to distribute stress and develop high thread tension. Is this harmful in repeated disassemblies? Not at all. Hex screws have been installed 50 times in cast iron test blocks, then tightened to failure without damage to tapped holes.

Clamps like a hex screw Grips like an anchor


thread tension (clamping force) produced when this face bears down
Flexing occurs at concentric groove
locking effect produced here by 24 embedded, carburized teeth

Tensilock® screws offer you the ideal combination of high clamping force and high locking power.

While a standard high strength hex screw can be tightened to a higher thread tension, its off-torque is less than its on-torque.

ANCHORED IN PLACE

The *"Tensilock"* screw features ratchet action teeth formed at an angle which will cut driving effort to permit you to utilize more of the full strength of screw. At equal driving torque, it not only develops 90% of the strength of a high strength hex screw but also takes *25% more torque to loosen than to tighten.*

Because of the flange's concentric groove, it flexes, allows the screw to bear down solidly on its seat and develop a high level of thread tension. At the same time the teeth embed themselves, are aided in maintaining their grip by pressure of the spring-action flange.

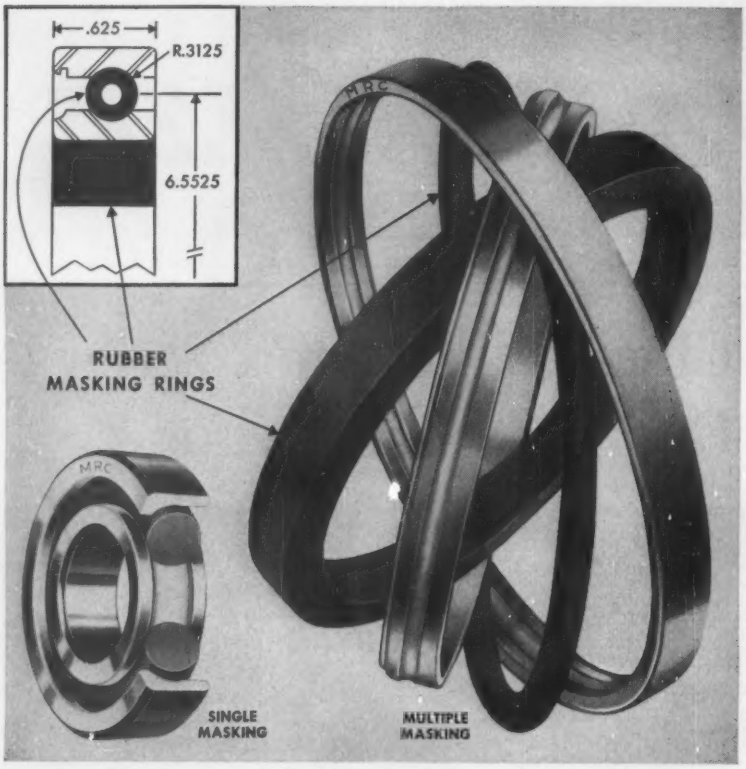
MAKES GOOD FRICTION-TYPE JOINT

Clamping force from Tensilock fasteners is sufficient to prevent slippage of fastened members where holes are oversize or eccentric. Grip of the teeth keeps fasteners tight under conditions of vibration or cyclic temperature changes. RB&W *"Tensilock"* Nuts also available. Write for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

® Registered and Patented

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa., Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Circle 568 on Page 19



Photos courtesy Marlin-Rockwell Corp., Jamestown, N. Y.

Rubber Rings Mask Bearings during Plating Process

Here's a new way to mask out plating on bearing race grooves without tedious hand-labor. Regardless of bearing size, rubber rings are fitted precisely into ball grooves and inner ring bore so that plating can't sneak under the rubber even in torturous electroplating baths. Clean division lines always result. Inner ring and outer ring are held together so both can be plated simultaneously. This saves one complete plating cycle. And, this fast assembly prepares bearings for plating in seconds—eliminates costly hand-painting with unreliable stop-off lacquer.

These rubber rings are the result of Marlin-Rockwell Corporation (Jamestown, New York) consulting Continental to solve an important masking problem. Creative engineering successfully developed these extruded and spliced, or molded rubber rings which increased production 2000%—20 times faster than hand-painting. What's more, the special rubber compound withstands repeated baths in blistering acids and caustics without affecting precise dimensions, elasticity or resilience.

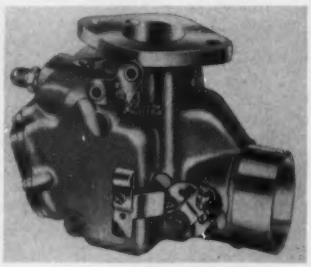
This rubber ring technique is typical of the thinking and ingenuity behind rubber parts by Continental. It also represents the economy and better end results accomplished by consulting a rubber specialist *during the planning stage* of a product. If you need help like this, call or write Continental —rubber specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1984 LIBERTY ST. • ERIE 6 • PENNSYLVANIA



teristics. Size of the unit is compact 1½ in., and weight is 4 lb. Accelerator pump is full vacuum operated. Carburetor is designed for extreme angular operation. Stainless-steel throttle shaft operates on needle bearings, and Nylock idle needle avoids fuel and air seepage. **Marvel-Schebler Products Div., Borg-Warner Corp.**, Decatur, Ill.

Circle 756 on Page 19

Subminiature Potentiometer

withstands 50 g vibration and 100 g shock

Model 540, WeeTrim subminiature trimmer potentiometer withstands 50 g vibration and 100 g shock and acceleration, well above MIL-R-27208/4 specifications. Standard features include 2-w rating, operation to 200 C, and humidity-proofing. Unit excels in resolution, insulation and dielectric strength, and

noisefree operational life. **Handley Inc.**, 12960 Panama St., Los Angeles 66, Calif.

Circle 757 on Page 19

Adhesives

for cementing vinyl plastics

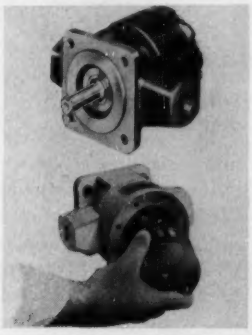
Two adhesives, made from a latex polymer, are designated Plastix Wet Stick and Plastix Heat Seal. They adhere unsupported plastic to cotton, wood, leather, acetate, mylar, paper, foam rubber, polyurethane foam,

and other materials. Adhesives are easily applied by roller coater, spray, or brush, and are also available in heavier viscosities for doctor-blade application. They dry rapidly to form transparent, tack-free surfaces that do not discolor materials. Water-based, the adhesives weld to plastics with an exceptionally strong bond which resists both washing and dry cleaning. **Adhesive Products Corp.**, 1660 Boone Ave., New York 60, N. Y.

Circle 758 on Page 19

Dual-Vane Pumps

feature complete cartridge construction



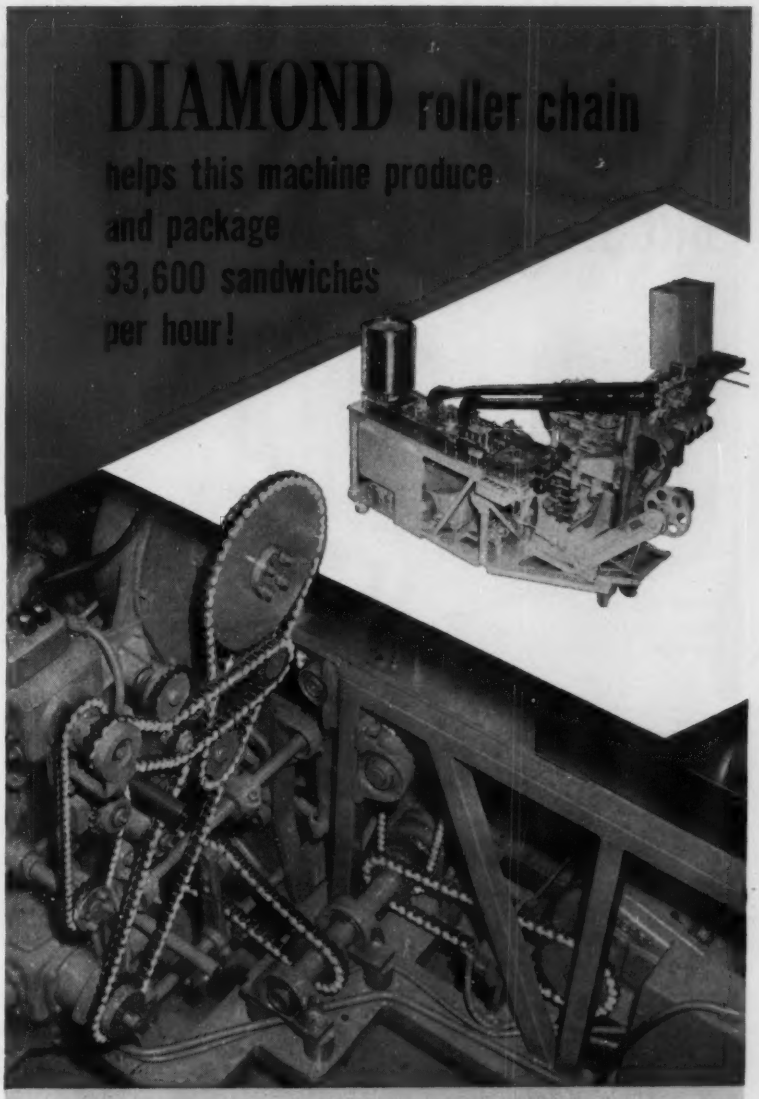
Single and double dual-vane pumps incorporate full-bearing cam rings and port plates. Designated Series PF100, pumps feature complete cartridge construction, enabling the units to be serviced quickly because all pumping parts are contained in an easy-to-install cartridge. Pumps, which can be driven by a flexible coupling, gear chain, or belt, are designed for industrial and mobile-equipment applications. **Hydreco Div., New York Air Brake Co.**, 9000 E. Michigan Ave., Kalamazoo, Mich.

Circle 759 on Page 19

Tapping Screws

for aluminum structures

New self-drilling tapping screws are available with acorn washer heads, indented hex heads, Phillips, and slotted heads. All have an extremely hard needle point. A minimum of pressure is required to drive the screws into the aluminum. Known as Uni-Point, screws are bright hardened Type 410 stainless steel,



560 sandwiches every minute—made, stacked 4 to a package, wrapped and sealed—by The Lynch Corporation / Quality Machine Company combination unit. The secret is perfect synchronization and split-second timing at high operating speed...a typical example of DIAMOND Roller Chain precision performance.

Whatever your application—conveying, timing, synchronization, power transmission—you can rely on dependable, accurate DIAMOND Roller Chain for a long life of low-cost, trouble-free service.

DIAMOND CHAIN COMPANY, INC.
A Subsidiary of American Steel Foundries
Dept. 435 • 402 Kentucky Avenue, Indianapolis 7, Ind.
Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS ®

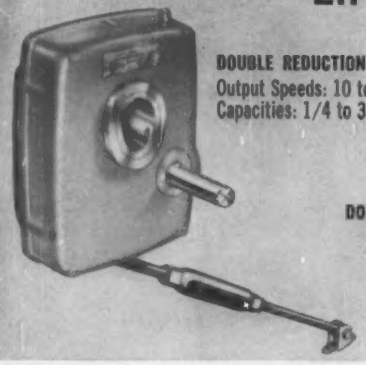
Circle 570 on Page 19

AVAILABLE FROM LOCAL STOCK

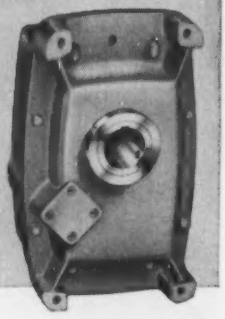
FOOTE BROS. SHAFT MOUNTED DRIVES

WITH Duti-Rated® LIFETIME GEARING*

SINGLE REDUCTION
Output Speeds: 90 to 420 RPM
Capacities: 1/4 to 40 HP



DOUBLE REDUCTION
Output Speeds: 10 to 160 RPM
Capacities: 1/4 to 30 HP

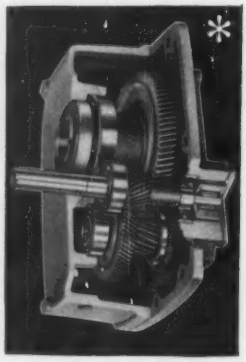


DOUBLE REDUCTION FLANGE MOUNT
Output Speeds: 10 to 135 RPM
Capacities: 1 to 7 HP

Foote Bros. Shaft Mounted Drives offer more efficient, more economical, power transmission. They incorporate exclusive Duti-Rated Lifetime Gearing — the high hardness, balanced design, premium quality gearing that combines greater load carrying capacity with long service life.

Used with standard V-Belts and Sheaves, Foote Bros. Shaft Mounted Drives will provide virtually any output speed you may require. Quick, easy installation on driven shafts with diameters from 15/16" to 3-7/16" saves time, labor . . . eliminates need for reducer mounting, couplings, and adjustable motor mount. Built-in Backstop to prevent reverse rotation, Automatic Overload Release Torque Arm, Variable Pulley, are available as optional equipment.

The complete Foote Bros. Shaft Mounted Drive line is made in accordance with all applicable AGMA Standards



Write for NEW SHAFT MOUNTED DRIVE CATALOG

FOOTE BROS. GEAR AND MACHINE CORPORATION
4567 South Western Boulevard, Chicago 9, Illinois
POWER TRANSMISSION DRIVES

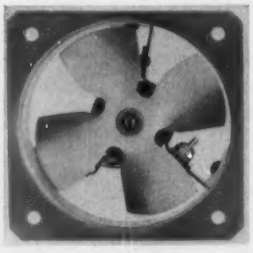
which combines high strength and corrosion resistance under all atmospheric conditions, as well as other metals. Screws are available in various sizes. **Universal Screw Co.**, 2401 Brummel Place, Evanston, Ill.

Circle 760 on Page 19

Axial Cooling Blower

miniature unit is all aluminum

Miniature axial-blower unit, MSA-11050, furnishes high efficiency, long life, and quiet operation in such electronic cooling applications as power supplies, radar transmitters, and test equipment. Supplied with a 60-cps motor, the all-aluminum unit is rated 12 cfm at 3600 rpm and a static pressure of 0.20 in. of water. Weight of the blower unit is only ½ lb, and over-all dimensions are 2.94 in. wide, 3.44 in. high, 3.50 in. deep. **Specialty Blower Div., Torrington Mfg. Co.**, Torrington, Conn.



Circle 761 on Page 19

High-Performance Switch

is sealed against dust, oil, moisture

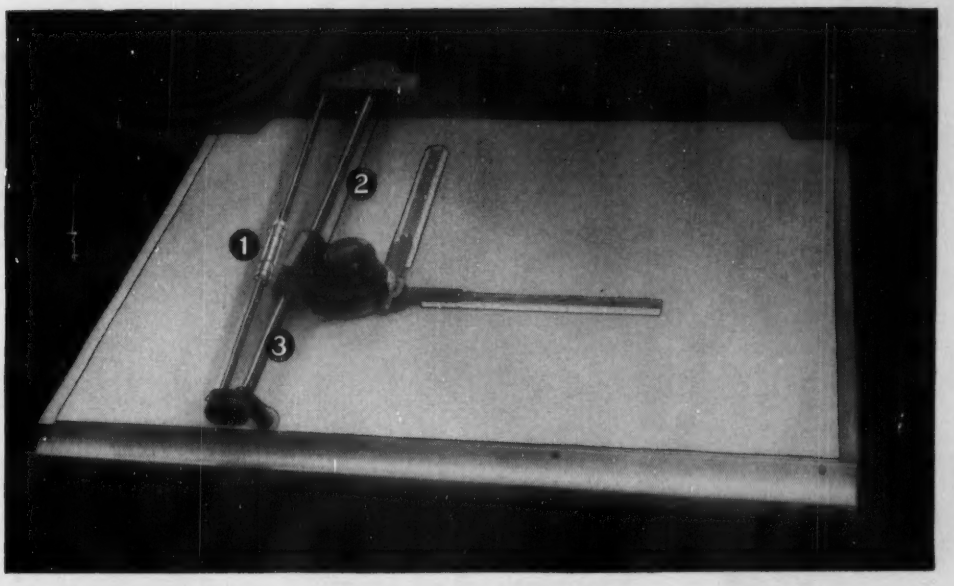
For applications in which there is exposure to splashable liquids, or where condensation is a problem, new low-cost, high-performance A60 switch has case halves perma-

Makes even the best draftsmen better

PARAGON

Auto-Flow®

DRAFTING MACHINE



3 Ways Better

1. Horizontal positioning lock now centrally located to permit locking or releasing while seated.
2. Improved cable attachment and increased cable strength provide maximum protection against breakdown, cable-snapping, and the wear and tear of constant use.
3. Larger diameter vertical rail and attendant structural improvements afford increased rigidity for sharper, surer work.

5 Ways the Best

More Versatile—perfect balance at any board angle.

More Compact—advanced travel-rod construction completely eliminates outdated cumbersome counterbalances projecting over top of board.

More Adaptable—gives maximum sweep of *any* size board—even the largest wall models.

Better Made—as with every K&E product, precision engineering throughout... rigid construction means truer lines, more accurate work... glides smoothly on fine-ground stainless rails... all glide controls are readily adjustable for any touch, any board.

For Easier Use—scales move instantly at the lightest touch from one position to another... long lines can be drawn in a single motion, up, down or across... scales *lock* in place to eliminate drift... less tiring... smooth feather-light action *actually reduces* number of arm and hand motions necessary to produce a finished drawing.

K+E

KEUFFEL & ESSER CO., Dept. MD-11, Hoboken, N. J.

☐ Please send information on the new K&E Paragon Auto-Flow® Drafting Machine.
☐ Please arrange a demonstration for me.

Name & Title_____

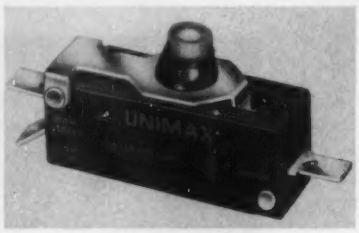
Company & Address_____

3548 R

Feature by feature, compare this new Browning bearing unit with any other. It is the only heavy duty roller bearing with eccentric locking collar, ensuring firm grip to the shaft. It is designed with housing of *unbreakable malleable*, which provides extra strength, permits more compact design, lighter weight. And it incorporates a new tapered roller arrangement specially designed by Timken for Browning, to compensate automatically for normal misalignments. Labyrinth seals retain the lubricant, shut out dirt; elongated bolt holes provide wide adjustment and maximum interchange.

Browning distributors, coast-to-coast, stock these new tapered roller bearing units in 24 shaft sizes from 1 3/16" to 4"; completely assembled, ready for use. Ask your distributor for full information and new descriptive bulletin BU-102A. Or write **Browning Manufacturing Company, Maysville, Kentucky.**

nently sealed together. Flexible silicone boot seals the clearance between case and operating button. Sealed switch is furnished with plain button, hinged lever actuator, or hinged roller-lever actuator. Switch is rated for single-pole, double-throw operation at 15 amp, 125/250 v ac; ¾ hp, 125 v ac; or 1½ hp, 250 v ac. Quick-connect terminals for snap-on connection of



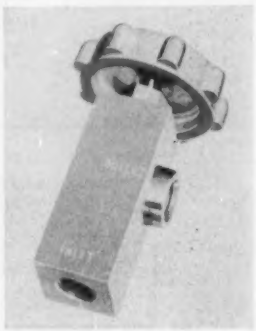
electric wiring are standard. **Unimax Switch Div., W. L. Maxson Corp.**, Ives Road, Wallingford, Conn.

Circle 762 on Page 19

Shutoff Valve

for temperature from −40 to +450 F

Series 900 leakproof, high-pressure shutoff valve features full-flow passage and foolproof O-ring sealing. Valve is of right-angle configuration for maximum mounting convenience. R900 valve has a single inlet and outlet; Y900 has a single inlet and two outlets; Z900, two inlets and a single outlet. Basic stainless-steel construction, coupled with a choice of O-ring materials, permits use with practically any gaseous or liquid service medium. Buna-N, Neoprene, or Viton A O-rings are available. Operating temperature range is −40 to +450 F, and operating pressure range is 0-6000 psi with zero leakage. All



Circle 573 on Page 19

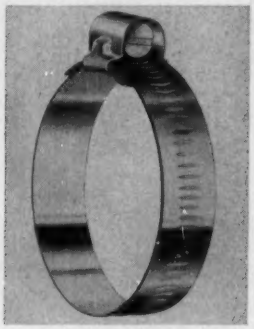
valves are proof-pressured at 7500 psi, and burst pressure is well over 20,000 psi. **Circle Seal Products Co. Inc.**, 2181 E. Foothill Blvd., Pasadena, Calif.

Circle 763 on Page 19

Hose Clamp

has no perforations through band

New hose clamp has no perforations through the band to cause extrusion or scuffing of rubber. Steel screw engages on coined threads, and clamp can be removed easily. It also provides uniform clamping pressure and will not distort thin-wall tubing. Wide-diameter adjustment is possible because of a high-



strength band. Band take-up is directed away from fastening side of housing to eliminate interference during assembly. Deep-slotted steel screw is encased in the housing to allow easy, positive screwdriver engagement. Clamp is available in a wide range of sizes and choice of materials. **Marman Div., Aeroquip Corp.**, 11214 Exposition Blvd., Los Angeles 64, Calif.

Circle 764 on Page 19

Automatic Transmission

for 2-4 hp gasoline engine-driven vehicles

Variable-speed automatic transmission unit, Vari-Dyne 400 torque converter, provides an automatic transmission of power from 2 to 4 hp gasoline engine-driven vehicles and equipment such as scooters, golf cars, garden tractors, and lawn mowers. At engine-idling speed, drive pulley rotates freely within the

N-83 ACTUAL SIZE

NEW G-E GLOW LAMP (NE-83) EFFECTIVELY HANDLES CURRENTS UP TO 10 m.a.

Here's a General Electric Glow Lamp that operates at currents many times higher than most glow lamps. At 10 milliamps, the NE-83 will hold its breakdown and maintaining voltage within five volts of initial for an average life of 500 hours. Life will be correspondingly higher at lower currents.

Although this product is too new for us to establish voltage regulation specifications, it shows considerable promise for this application in the 1 to 10 milliampere range.

Leads of the NE-83 are plated for easier soldering. It contains a mild radioactive additive to reduce breakdown voltage in darkness.

DIRECT CURRENT SPECIFICATIONS

Breakdown Voltage	60-100 volts d-c
Maintaining Voltage at 10.0 m.a.	avg. 65 volts d-c*
Design Current	10.0 m.a. d-c
Life (at 10 m.a. d-c for an average change of 5 volts in breakdown and maintaining voltage)	500 hours

*Average after 100 hours burning at rated current. Individual lots may vary from average.

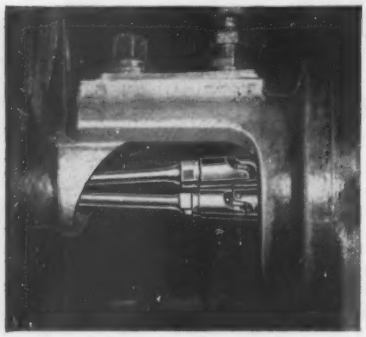
There's a General Electric Glow Lamp to suit every circuitry need. For the latest information on Glow Lamps as Circuit Components and Indicators, write for 4-page Bulletin #3-0193. General Electric Co., Miniature Lamp Dept. M-038 Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 574 on Page 19

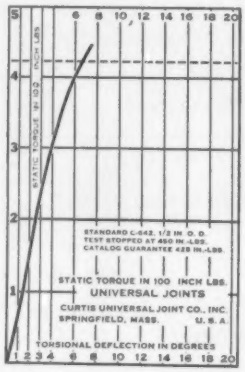
Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.

Torque Curve ½" Curtis Universal Joint


STATIC TORQUE IN INCH LBS.
STANDARD C-642, 1/2 IN. O.D.
TEST STOPPED AT 400 IN.-LBS.
CATALOG GUARANTEE 428 IN.-LBS.
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UNIVERSAL JOINTS
CURTIS UNIVERSAL JOINT CO., INC.
SPRINGFIELD, MASS. U. S. A.
TORSIONAL DEFLECTION IN DEGREES

This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

14 SIZES ALWAYS IN STOCK —
3/8" to 4" O.D. (6" joints on special order)

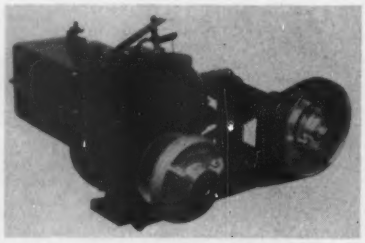
Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.
511 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Circle 575 on Page 19



slack belt. As engine is accelerated, drive pulley engages belt to start load smoothly. Speed ratios between the two pulleys range from 3:1 reduction at start to 1:1 at operating speeds. After vehicle is underway, ratios automatically change to compensate for varying speeds and loads subjected to the engine. **Salsbury Corp.**, 1161 E. Florence Ave., Los Angeles 1, Calif.

Circle 765 on Page 19

Seamless Tubing

in Nichrome V

Tubing in sizes from 0.010 to 0.375-in. OD is available in Nichrome V, 80 per cent nickel and 20 per cent chromium alloy. Featuring good electrical resistance, ability to withstand temperatures to 2100 F, and good corrosion resistance, tubing is especially suitable for resistance-heating elements, thermocouple protection tubes, and instrument components. **Uniform Tubes Inc.**, Collegeville, Pa.

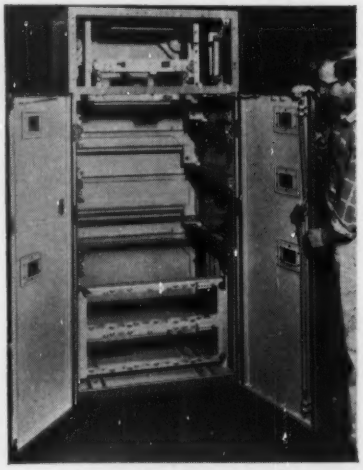
Circle 766 on Page 19

Air Cylinders

in stroke lengths to 3 in.

Improved double-acting, stainless-steel air cylinders are now available with rolled-in construction on the rear head as well as the front head. The 1 1/16-in. bore cylinders are available in stroke lengths through 3 in. Wall thickness of the stainless-steel body has been

Example . . .



. . . of B & P capability to make lightweight metal assemblies for electronic equipment

Designing and manufacturing products and assemblies of light metals is a highly specialized field. Techniques unknown to production in other metals must be understood and new ones must be developed for unusual requirements.

Because it has concentrated on light metal manufacturing for many years, Brooks and Perkins today has experience and capability unmatched by any other organization.

The Nike-Hercules system magnesium cabinet shown above is just one example of B & P skill in maintaining close tolerances and optimum precision. Other products and assemblies designed and produced by B & P include . . .

• cooler plates • radar reflectors • communication equipment covers • radar reflector bases • equipment housings • tripods • radar plotting equipment • shelters • transit cases • gun fire control housings and turrets

When you need lightweight products or assemblies for electronic equipment, take advantage of B & P's experience and capability.

BROOKS & PERKINS, INC.
1940 W. Fort St., Detroit 16, Mich.
Offices in Washington and New York

61-T-2

Circle 576 on Page 19

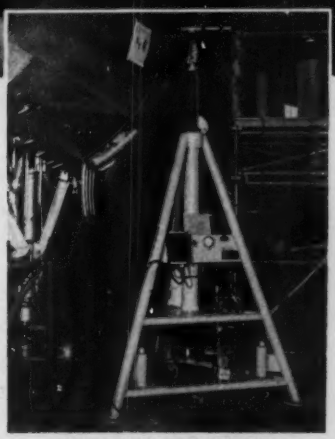
HOW ACIPCO HELPS CANADAIR KEEP 'EM FLYING

HYDRAULIC CYLINDER JACKS USED IN AIRCRAFT CONSTRUCTION AND MAINTENANCE EMPLOY ACIPCO CENTRIFUGALLY SPUN TUBING

The 10-ton hydraulic wing jack shown here is one of a number of different capacity jacks utilized by Canadair in its aircraft plants near Montreal. The hydraulic cylinders of these jacks are ACIPCO centrifugally spun tubing . . . and the manufacturers were supplied with Type 4130 normalized and tempered tubing in a variety of sizes ranging from 6½" O.D. to 11½" O.D.

"You may like to know, your material met our rigid specifications in every respect," wrote the manufacturer to ACIPCO, "and its excellent quality is such that the cylinders will render satisfactory, trouble-free service. The exceptional machinability of your tubing proved a definite asset in the manufacture of our cylinders."

ACIPCO tubing serves thousands of applications in hundreds of industries . . . economically . . . efficiently. May we serve you?



VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

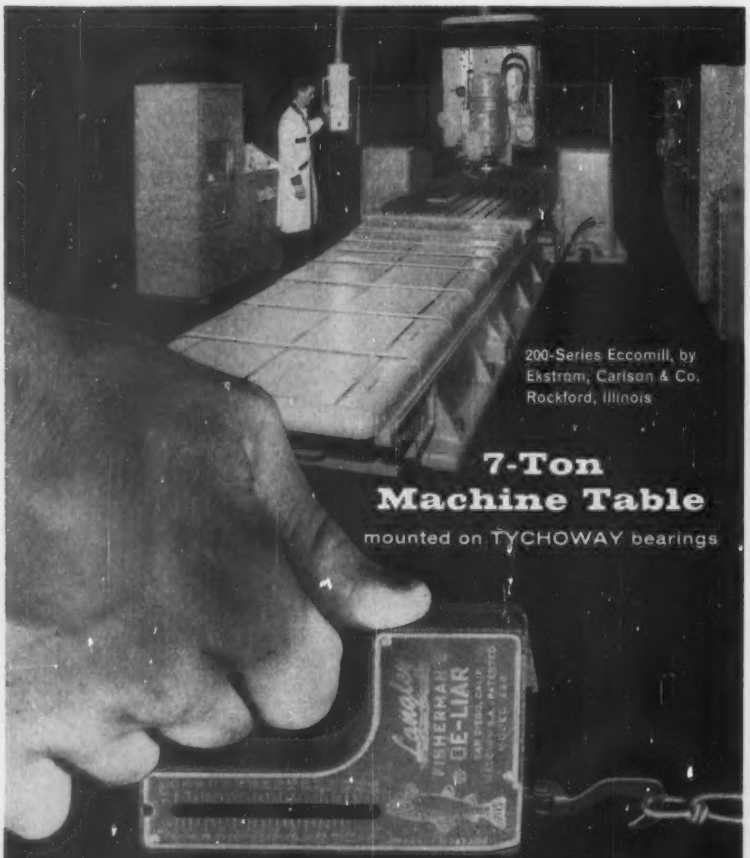
SIZE RANGES: Tubes are produced in lengths from 4' to 20'; longer lengths are made by welding. O.D.'s from 2.25" to 50"—wall thicknesses from .25" to 8".

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels, plain carbon steel and special non-standard analyses.

FINISHES: As cast, rough machined, or finish machined, including honing and grinding. Complete welding and machine shop facilities are available.

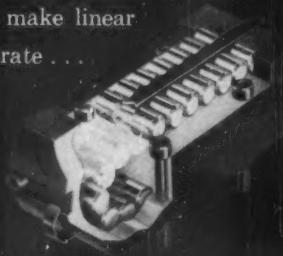
ACIPCO
SPECIAL PRODUCTS
DIVISION OF AMERICAN CAST IRON PIPE CO.
BIRMINGHAM 2, ALABAMA

Circle 577 on Page 19



MOVES UNDER 35-POUND PULL

Only 35 lb force moves the 7-ton table of this numerically controlled milling and profiling machine. Scully-Jones Tychoway recirculating roller bearings equalize starting and running friction—eliminate stick-slip inaccuracies of mating way surfaces. 10,000-lb workpieces can be positioned smoothly and accurately. Tool positioning and path control also are precise because Tychoway bearings are used on the vertical slide and saddle. Friction surfaces are "old hat" in today's precision machine tools. Scully-Jones Tychoway recirculating bearings and Super-Cision ball screw actuators make linear motion more predictable and accurate . . . reduce power requirements . . . simplify assembly. Write for Bulletins No. 22-50 and 25-50.



SCULLY JONES

Scully-Jones and Company

1905 South Rockwell St., Chicago 8, Illinois
Phone: Bishop 7-5900

Circle 578 on Page 19

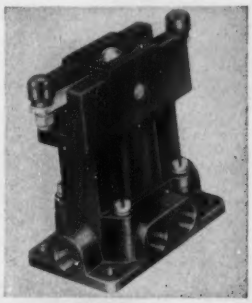
increased by 50 per cent. Smooth mirror finish of the body and use of piston U-cups provides long life. **Bimba Mfg. Co., 111 Main St., Monee, Ill.**

Circle 767 on Page 19

Directional Valve

for 250-psi air or hydraulic pressure

Poppet-type directional valve utilizes a removable pipe bracket which conserves space and allows valve to be removed for maintenance without disturbing pipe connections. Group mountings can also be made, without pipe bracket, to a common manifold. Both three-way and four-way operation models are available. By rearranging internal parts, operation can be changed. Six different operators are interchangeable. Suitable for 250-psi maximum air or hydraulic pressure and a temperature range of −40 to +160 F, valve is essentially die-cast zinc. All materials used are noncorrosive. Both ⅛ or ¼ in. tapped pipe brackets are available. **Industrial Products Div., Westinghouse Air Brake Co., Wilmerding, Pa.**

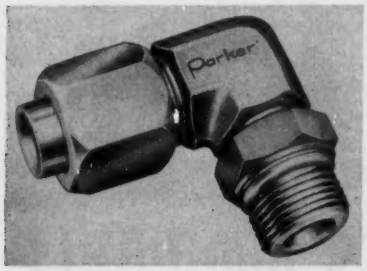


Circle 768 on Page 19

Metal Sealing Ring

for use on straight-thread fittings

Made of type-304 stainless steel, metal sealing ring is for use on straight-thread fittings where a conventional synthetic-rubber O-ring with back-up washer is not acceptable. Sealing ring works in standard SAE O-ring fitting boss, providing a metal-to-metal seating for a highly satisfactory seal. Ring handles high temperatures and rubber-attacking fluids, as well as high



pressures. Ring is provided on straight-thread steel and stainless-steel Triple-lok flared tube fittings, Ferulok bite-type tube fittings, adapter fittings, and Hoze-lok reusable fittings for industrial hose. Unit can be used and reused without damage to itself or to the boss. **Parker Fittings & Hose Div., Parker-Hannifin Corp.**, 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 769 on Page 19

Soft-Seam Adhesive

bonds closed-cell vinyl to itself and to fabric

Strong, flexible, soft-seam adhesive, Bondmaster R379-20, bonds closed-cell vinyl foam to itself and to fabric, as well as to phenolic and other plastics, to metal, wood, composition board and other rigid, semi-rigid, and flexible materials. Adhesive can be brushed, roll coated, or sprayed with conventional equipment to provide bonds which feature superior resistance to salt water and high humidity conditions, fatigue and vibration, hot oil, gasoline, aromatic fuels, and organic solvents, and prolonged exposure to temperatures to 250-350 F. Surfaces coated with the adhesive achieve bonds of foam-tearing strength instantly upon contact. **Rubber & Asbestos Corp.**, Dept. P, 225 Belleville Ave., Bloomfield, N. J.

Circle 770 on Page 19

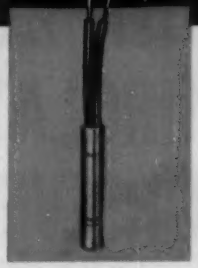
Motor-Starting Switch

for single-phase motors

Series 47-000.O-P switch is designed for simplified starting control of single-phase motors. Unit is suitable for pumps, refrigerators, fans, air conditioners, and other automatically operated devices for new

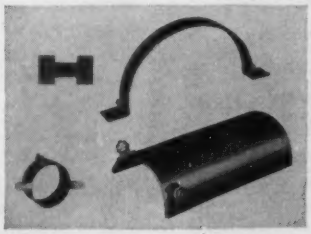
(*Please turn to Page 274*)

DEPENDABLE
ELECTRIC HEAT
COMES IN ALL SHAPES AND SIZES AT
WATLOW



Watlow FIREROD® CARTRIDGE HEATERS

New high in heat concentration . . . longer life . . . new design flexibility. Provides same heat as standard heating unit in 1/5 the size! Standard cartridge heaters also available.

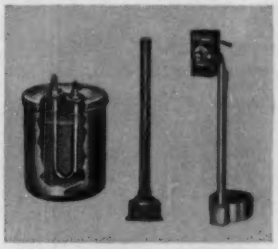


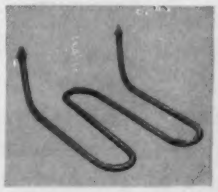
Watlow STRIP HEATERS

Straight or curved design. Widths ¾" and over, lengths to 72". Post, button and bracket type terminals and flexible leads.

Watlow IMMERSION HEATERS

Straight or curved. Diameter ¾" to 2", any length, with capacities to 10,000 watts.

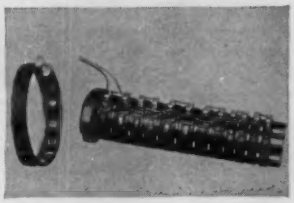




Watlow TUBULAR HEATERS

Available in sheath materials for all purposes . . . various terminals to meet special needs . . . in most voltages . . . in standard as well as odd lengths, diameters and wattages.

Watlow NARROW-BANDED HEATERS



Patented clamping band. Widths 1 to 2", diameters 1¾" and up. Watt densities up to 45 watts/sq. in. Standard cylindrical heaters in a wide variety of widths and diameters.

■ *Write for* FREE CATALOG *and let us help solve your electric heating problems.*

WATLOW
ELECTRIC MANUFACTURING CO.
1384 Ferguson Avenue
St. Louis 14, Mo.

Circle 579 on Page 19

WITH 2,000 STANDARD UNITS AVAILABLE, PUROLATOR HAS THE RIGHT FILTER FOR EVERY FILTRATION APPLICATION

The precisely-machined parts and close fits found in today's engines, machinery, and other equipment demand proper filtration for maximum output and long life. In fact, filtration has become a basic tool of the product designer.

Here are just five areas in which Purolator standard filters can result in improved design . . . in better performance and reduced wear for machinery. Filters illustrated use Purolator's famous Micronic® (resin-impregnated cellulose) and metal edge filter media. Other Purolator filters use porous metal and wire cloth as filter media.

Purolator is the world's largest, most experienced manufacturer of filters. Whether your design calls for filtering oils, gums or resins, chances are a standard Purolator filter will do the job. Consult your nearest Purolator office for details. Or, if yours is a specialized application, tell us about it. Write: Purolator Products, Inc., Rahway, New Jersey.

1. Air Intake Filtration. Purolator Dry Air Filtration positively prevents all contaminates from entering engine. After becoming clogged with dirt, conventional oil bath filters continue to let damaging, dust-laden air into the engine. On the other hand, a dry type filter like a Purolator Micronic unit positively filters *all* air entering the engine. Removes 99+% of all contaminates—regardless of working conditions.

Special preforming and pleating give the Micronic filter element 10 times more filtering area than many other filters of the same size. This means long service life at maximum efficiency.

Replacing the filter element is easy, too. Takes less than a minute. And because there is no oil to spill . . . no level to be maintained . . . the filter can be installed anywhere on the engine.

AF-200 series dry-type micronic air filter. Removing the single wing nut on the top is all that is required to replace the filter element.

2. Lubricating Oil Filtration. Purolator's "Selective" Filtration leaves Additives in Heavy-Duty or Detergent Oils. Improper filtering of lubricating oils can also remove costly, engine-protecting additives.

Controlled porosity of the Micronic® element of a Purolator Lubricating Oil Filter

P-32 Series Micronic Lubricating Oil filter can be mounted either horizontally or vertically. Emergency relief valve prevents oil flow from being shut off because of a clogged filter.

removes particles of dirt measured in microns (.000039-inch.) Yet, it never removes needed additives. These Micronic elements are unaffected by high temperatures or water. Never develop soft spots — or channel.

What's more — a Purolator Micronic Filter of correct size can handle *full lubricating oil flow* for even the largest engines. This eliminates the need for partial flow systems —whereby many harmful contaminates can remain in the lubricating system.

3. Gasoline Engine Fuel Filtration. Compact Purolator GF-11 Series Fuel Filter is Adaptable to Many Gasoline Engines. Particles of dirt as small as 10 microns in the fuel system can choke and stall a gasoline engine. Carburetors like the modern 4-barreled units especially need positive filtration for efficient operation.

Purolator's GF-11 Micronic Fuel Filter is especially designed for the job. Standard equipment on many 1961

GF-11 Fuel Filter fits many gasoline engines — from sports cars and garden tractors to power mowers and midget racers.

cars, it can be incorporated equally well into the fuel system of many gasoline engines.

Measuring only 3" x 1⅞", it can be easily installed either horizontally or vertically. Fully 70 square inches of filtering surface removes all contaminates down to 5 microns. Filter is designed as a throw-away unit . . . good for over 5,000 miles of operation.

P-192 high-pressure, high-flow hydraulic oil filter.

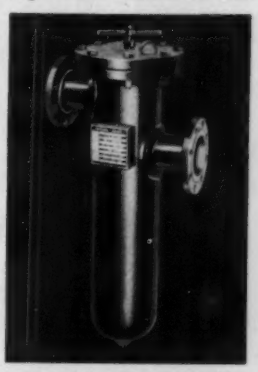
4. Hydraulic Fluid Filtration. Purolator has the Right Filter for Every Hydraulic System. Good design calls for adequate filtration of all hydraulic fluids. A little dirt can drastically lower the efficiency of system — or put it completely out of order. Even a closed system contaminates its own fluids with microscopic bits of metal worn from moving parts.

Hydraulic systems vary widely, and for top operating efficiency, the filter must be designed specifically for the job. Purolator offers a full range of standard filters for all hydraulic systems—ranging from tiny metal element filters for missiles to low- and high-pressure, high-flow Micronic filters for large earth-moving machinery.

5. Diesel fuel and lube oil filtration. Series G-144J Metal Edge Filters Offer Permanent, Uninterrupted Filtration for Fuel and Lube Oils. Standard equipment on many of the largest, most modern Diesel engines, the G-144J Filter requires an absolute minimum of maintenance.

Made of precisely-spaced metal ribbon wound in cylinder form, the filter element lasts indefinitely. Cleans by an occasional twist of the hand wheel on top of the unit which rotates the filter element against a fixed knife blade. No need to cut off the engine or to interrupt the flow of fuel.

Spacing of ribbon determines degree of filtration — which



Series G-144J Filter mounts either on suction or pressure side of pump. Relief valve is optional. If service warrants, filter element can be rotated continuously by motor drive.

ranges from 25 to 500 microns. Fine filtration is recommended for fuels. Less fine filtration . . . for lube oils.

Filtration For Every Known Fluid

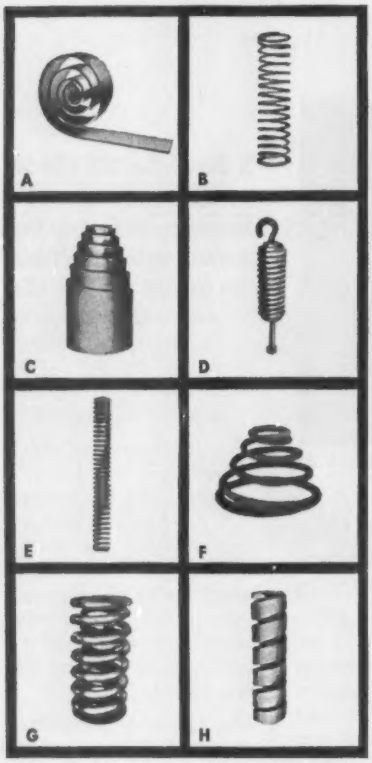
PUROLATOR

PRODUCTS, INC.

RAHWAY, NEW JERSEY, AND TORONTO, ONTARIO, CANADA

Circle 580 on Page 19

Can you identify these springs?



A. flat B. helical C. volute D. extension
E. helical F. cone G. helical, triple-coil
H. rectangular section

Over One Million
ALCO SPRING DESIGNS

ALCO's complete line of "performance-rated" springs ranges from small springs for light work to heavy-duty triple-coil springs for heavy, sustained work.

In over 80 years, ALCO engineers have produced more than one million spring designs to serve almost every conceivable application.

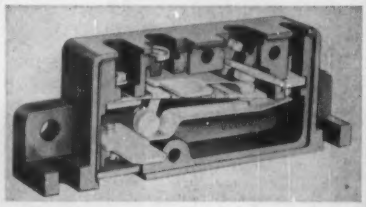
For your next spring job, contact your nearest ALCO sales office. To obtain brochure, ALCO *Springs for Industry*, write to ALCO Products, Inc., Dept. 160, Schenectady, N. Y.

ALCO

ALCO PRODUCTS, INC.
NEW YORK
SALES OFFICES IN PRINCIPAL CITIES

Circle 581 on Page 19

(Continued from Page 271)



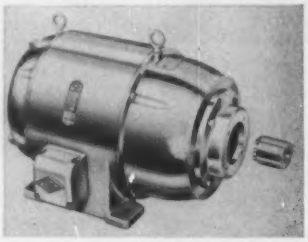
or existing motors. Switch can be installed in any position, has no sliding parts, and is resistive to contact freezing or flutter. For applications other than motor starting, unit can be modified for thermal relay use. Switches are rated from 200 ma to 10 amp at 250 v ac, with life span up to 1 million cycles. **E-T-A Products Co. of America**, 6248 N. Cicero Ave., Chicago 46, Ill.

Circle 771 on Page 19

Hydraulic Pumps

have intermediate ratings

New intermediate ratings permit users of hydraulic pumps to select the correct horsepower as required by a particular performance curve. Use of a motor with compatible horsepower permits increased operating efficiency and reduction in the cost of the motor itself. Intermediate ratings available as standard are: 2½, 4, 6¼, 8¾, 12½, 17½, 22½, 27½, 32½, 35, 37½, and 45 hp. Conventional ratings



from ½ through 60 hp are also available. Units are available in polyphase, dripproof, and totally enclosed types in frame sizes 182 through 365-U. **Reuland Electric Co.**, Alhambra, Calif.

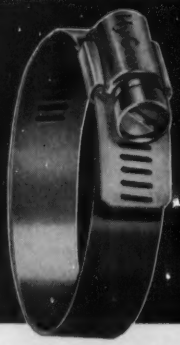
Circle 772 on Page 19

Low-Speed Generators

for 60-cycle applications

NoBrush generators for low-speed, 60-cycle applications have standard

Assembly Problem?
Clamp with HY-GEAR!



If the fastener you now use in your product risks corrosive attack, cannot be reused, costs too much to install, is not strong enough, undermines the effectiveness of your product—consider the versatility and economy of Hy-Gear worm drive clamps. Band and housing are premium stainless steel. Hy-Gear—available with either stainless steel or cadmium plated worm screw—installs easily, has a powerful grip—can be used over and over again.

Available in Three Styles

Safety-collared type is recommended when Hy-Gear is installed in confined areas... Collar prevents slipping of screw-driver—speeds tightening.

Non-collared economy type serves equally well when area of application is not restricted by space limitations. Has deep slotted screw for easy screw-driver tightening.

Thumb-screw type to enable hand tightening on laboratory apparatus, appliances and other equipment where frequent tightening and untightening is required.

For a sample of the style Hy-Gear that interests you ...or a catalog covering Hy-Gear and other Ideal clamps, write

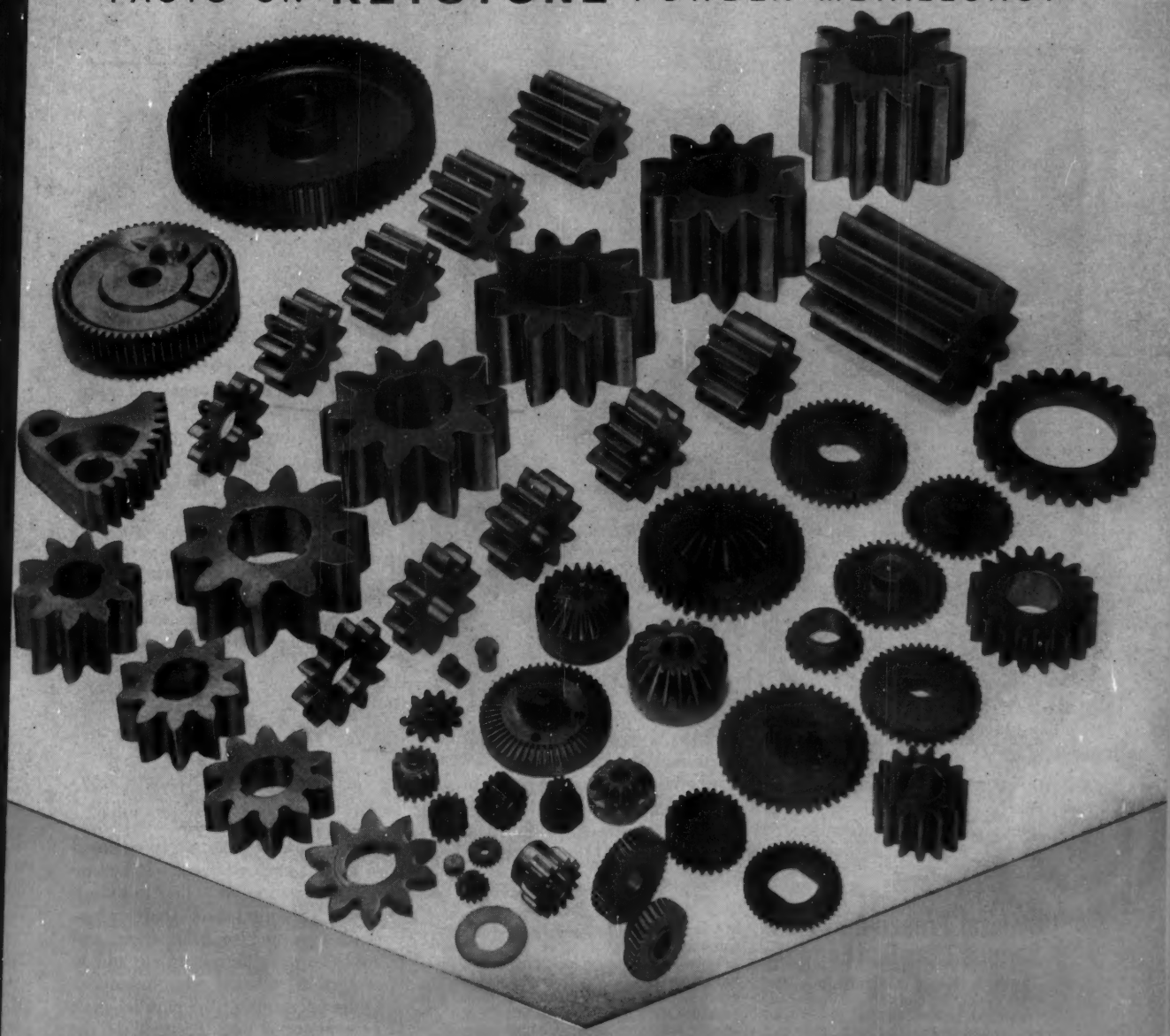
IDEAL CORPORATION
427 Liberty Avenue
Brooklyn 7, N.Y.

Headquarters for clamps since 1913

ideal Corporation

Circle 582 on Page 19

FACTS ON **KEYSTONE** POWDER METALLURGY



THE PLACE OF GEARS

IN KEYSTONE POWDER METALLURGY

A few years ago, the simplest gear shapes seemed remarkable in themselves as they came chuting from the powder metal presses. Those uncomplicated spur gears exemplified all the tenets of powder metallurgy—low cost, high volume parts that required no expensive machining, and delivered excellent service in the right applications.

But our progress has moved swiftly in sintered gears since those pioneer days. The development of better materials has opened up many new medium- and high-strength applications to powder metal service. Imaginative tool engineering and press design have made possible the widest range of gear types . . . clusters, bevels, pinions, sectors, helicals . . . saving progressively more money as designs become more complex.

Today, gear production at Keystone is major in importance. We can meet your requirements to the dot in type, material, quantity, delivery and performance. In brief, we're geared to serve. Call us!

Keystone CARBON COMPANY
ST. MARYS, PA.
POWDERED METAL PARTS DIVISION

Circle 583 on Page 19

These RMC thermometers have just been submerged in water for the first of a severe series of tests to make sure of perfect hermetic sealing.

Moisture will never bother your RMC dial thermometer

The RMC hermetic sealing process makes absolutely certain that humid air will not be sealed in the instrument and locks all moisture out permanently. Each thermometer then goes through a series of severe tests. Only those with perfect sealing are accepted for delivery. When you order from RMC you get the *only* industrial thermometer that can *never* be affected by internal dial fogging or bimetal freeze-up.

"Bimetal Freeze-up" More Serious Than Dial Fogging

The first sign of moisture in a dial thermometer usually shows up as condensation inside the dial glass. You are probably familiar with this dial fogging problem which causes difficult reading and the eventual corrosion of the bimetallic element. You may not, however, be familiar with another and actually more serious moisture problem—bimetal "freeze-up."

If moisture is sealed in, or enters a thermometer dial it will find its way to the bimetal element. Then at extreme low temperatures this moisture freezes on the element and bearing surfaces, and the bimetal element will not function should the temperature go lower. Therefore, the operator of the equipment would never know that the temperature had gone below the last indication when the element became frozen.

Here's what makes such a condition hard to spot. The thermometer would operate properly again after a temperature rise of perhaps 20°, and would continue accurate indication even though the fluid dropped again to an even lower temperature than before. However, after it remained at the new low for a few hours, it would again freeze up. Then, as before, any further drop in temperature would not be indicated.

Only a dry-air hermetic seal, as used by RMC, can prevent both dial fogging and bimetal freeze-up. RMC even goes a step further by providing for recalibration at any time without breaking the air-tight seal. An external dial reset screw—exclusive with RMC—permits recalibration without opening the instrument in any way.

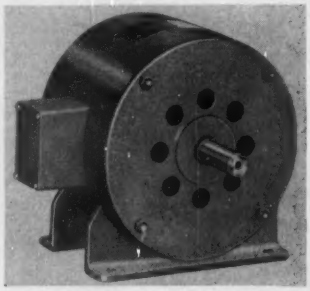
Write, wire or phone for general catalog. If yours is a special application, tell us your requirements—RMC engineers will work with you in solving it. Rochester Manufacturing Co., 229 Rockwood St., Rochester 10, N. Y. (Telephone: BRowning 1-2020).

RMC

ROCHESTER MANUFACTURING CO., INC.
229 ROCKWOOD STREET • ROCHESTER 10, N.Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES



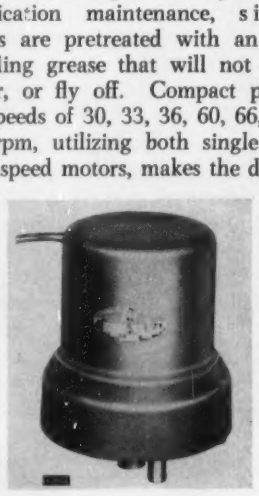
brushless, permanent-magnet design. Units reduce operating maintenance to the equivalent of that required by three-phase induction motors. Generators feature sealed, lubricated-for-life ball bearings, high overloading capacity, and excellent resistance to damage by short circuit. Units deliver 60 cycles at 1200 rpm, with power rating of 0.25 kva, three phase. Units withstand high ambient temperatures. Georator Corp., Manassas, Va.

Circle 773 on Page 19

Gear Motor

is totally enclosed, quiet-operating unit

New gear motor is totally enclosed to permit easy cleaning. It has no flats or crevices to collect contaminants. Stainless-steel shaft extension, wipe-on gear lubrication, and adhesive metallic nameplate add to protection against contamination. Quiet operation of the parallel-shaft gear motor is due to design of the helical steel and phenolic gear train that is completely supported on ball bearings. It requires no lubrication maintenance, since gears are pretreated with an embedding grease that will not drip, wear, or fly off. Compact power in speeds of 30, 33, 36, 60, 66, and 72 rpm, utilizing both single and two-speed motors, makes the design



Circle 584 on Page 19

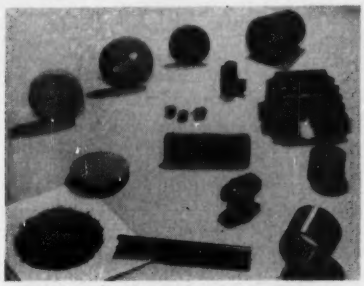
applicable to many functions, such as small conveyors, pumps, mixers, and agitators. **Franklin Electric Co. Inc.**, 400 E. Spring St., Bluffton, Ind.

Circle 774 on Page 19

Silicone Molding Compound

for molding of parts used to 700 F

Mineral-filled silicone molding compound, M-6-4156, is available for molding of parts used in long-term operation to 700 F. Units molded from the granular, thermosetting material have outstanding dimensional stability and thermal shock resistance over a temperature range



of −67 to +700 F. Parts demonstrate high arc resistance, over 400 sec, and dissipation factors as low as 0.002 at 10^6 cycles per second. Material is easily molded using conventional compression or transfer molding equipment. **New Products Dept., Dow Corning Corp.**, Midland, Mich.

Circle 775 on Page 19

Flat Band Clamps

have uniform peripheral clamping action

Types 10Q1 and 10T flat band clamps are high-tensile stainless steel with standard A or AN self-locking nut. Uniform peripheral clamping action is assured with balanced design and construction. Clamp diameters range from 2¼ to 10 in. Type 10QL quick-latch clamp meets rigid military standards for hose and duct connections where easy installation and fast removal are important. Latch construction gives positive assurance against accidental disconnect. Type

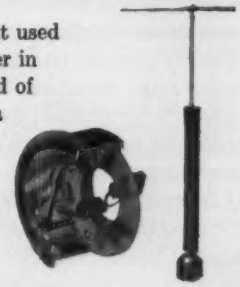
The photograph below shows RMC Pressure Gauges undergoing severe vibration testing on big Calidyne High Frequency Vibration Test System. These gauges undergo accelerated tests from 0-2000 CPS—up to 25 G intensity and up to 350° F.

RMC *direct-drive* Pressure Gauge eliminates vibration problems

The RMC *direct-drive* Pressure Gauge is rugged and resilient. It is the first direct-drive helical bourdon gauge—inlet pressure acts directly on a helical bourdon to drive the pointer. The helical coil, as a simple spring, is resilient and fully balanced, and is not affected by shock or vibration.

With its direct drive, there are no gears or linkage to gyrate and score on vibration—no unbalanced bourdon "C" springs and hair springs to whip. Direct-drive action means a stable pointer—no loss of power, too. Pointer action of the RMC gauge is steady, positive and alive—no need to tap the gauge to read. Soft hair springs and backlash springs are not used.

Shown at far right is the pointer-coil unit used in 3″ and 5″ concentric models. The pointer in these models is attached directly to the end of the pressure element. At the near right is a cutaway view of the compact 1½″ and 2″ eccentric models. The pointer in these models is actuated directly by a simple pivot. Both types offer the same direct-drive, helical bourdon advantages. Pressure ranges from 0-1000 to 0-10,000 psi.



Write, wire or phone for general catalog. If yours is a special application, tell us your requirements—RMC engineers will work with you in solving it. Rochester Manufacturing Co., 229 Rockwood St., Rochester 10, N. Y. (Telephone: BRowning 1-2020).

RMC

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

ROCHESTER MANUFACTURING CO., INC., Rochester, N.Y.

Circle 585 on Page 19

From New York to Los Angeles and back–3½ times!

annual production capacity of ultra-thin metal strip now totals 96 million feet

Production capacity of ultra-thin metal strip and foil at Precision Metals Division of Hamilton Watch Company today is unmatched by any other plant in the world. This unique metals processing plant is now capable of an estimated annual volume of more than 18,000 miles of ⅛" x .000125" strip.

thicknesses from .100" to .0001" Hamilton precision strip and foil is available in virtually any alloy cold rolled in a thickness range from .100" to ultra-thin .0001" in widths up to 10". Precise control of metallurgical and physical properties is maintained at all times.

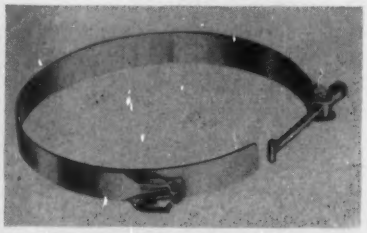
comprehensive metallurgical facilities The Precision Metals Division is a completely integrated metals processing plant with facilities available for development and production. Special alloys to your own specifications can also be furnished in the form you require. For information write today for Facilities Booklet MD-11 and Technical Data Sheets on such metals as Stainless Steel, Magnetic Alloys, Alfenol, Havar and Elinvar Extra.

HAMILTON

WATCH COMPANY / **Precision Metals Division**

Lancaster, Pennsylvania

Representatives
COREY STEEL COMPANY • Chicago, Illinois
FAGERSTA STEELS PACIFIC, INC • Los Angeles, California



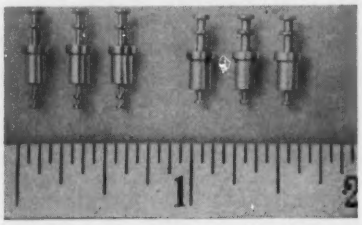
10T T-Bolt clamp is the same as Type 10QL, without quick-latch feature, and is recommended for more permanent applications. Wittek Mfg. Co., 4305-43 W. 24th Place, Chicago 23, Ill.

Circle 776 on Page 19

Feed-Through Terminals

have shank diameter of 0.125 in.

Two feed-through terminals are processed from quality brass per QQ-B-626a, Comp. 22, ½ hard with 0.003-in. silver plate plus water dip lacquer. Terminal 1035 has double turrets at each end. Height, when mounted, is 0.241 in. on one end and 0.134 in. on other end. Terminal 1036 has double turrets at one end and a single turret at the other. Height of double-turret terminal, when mounted, is 0.241 in., and of



single-turreted terminal, 0.082 in. Both terminals have shank diameters of 0.125 in. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 777 on Page 19

Epoxy-Glass Laminate

has excellent machinability

Micaply EG-818 (unclad) and EG-818-T (copper clad) laminates are nonburning when tested in accordance with ASTM D635. Laminates meet the requirements of MIL-P-18177B (Type GEE), MIL-P-13949B (Type GF), and NEMA

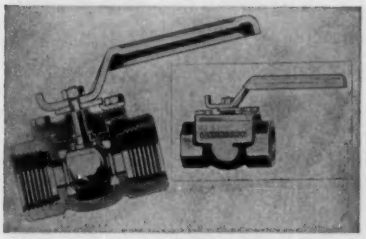
Circle 586 on Page 19

Grade FR-4 (Proposed). Grade EG-818-T is an all-purpose laminate which can be dip-soldered and/or electroplated, and/or vapor degreased without detrimental effect. No adhesive is used to achieve the excellent bond strengths available. Laminate has machinability comparable to regular G-10 materials, while exceeding flame-retardent properties of G-11. Thicknesses are 1/32, 1/16, 3/32, and 1/8 in., in sheet size 18 x 36 in. **Mica Corp.**, 4031 Elenda St., Culver St., Culver City, Calif.

Circle 778 on Page 19

Ball Valve

has top entry through removable cover



No. 700 ball valve incorporates top entry design which makes possible easy in-line maintenance. Entry through a removable cover exposes the ball, which is easily removed by a tool on the valve handle. Ball is flat on both top and bottom, enabling it to be removed from the body for easy access to the seats. Self-aligning ball rides on its seats, sealing at high or low pressure without springs or bearings. O-Ring seals of Teflon or Buna-N protect against leakage at stem and cover. Valve has bronze body, screw ends, and accommodates pipe sizes from 1/4 to 2 in. **Lunkenheimer Co.**, P.O. Box 360, Annex Station, Cincinnati 14, Ohio.

Circle 779 on Page 19

Clutches and Brakes

are Size-8 units

Precision Size-8 magnetic clutches, brakes, and clutch-brakes feature high torque and low starting friction. Other features include fast response time and reliable performance to latest military en-

MOLINE FARM EQUIPMENT

Chooses Whitney MSL*

SELF-LUBRICATING CHAIN

Whitney MSL A-2040 Double Pitch Transmission Series used as main drive on Moline RB-12-10, 16-10, and 16-8 Grain Drills.

Dirt, Abrasive Dust, Rough Service No Problem to This Chain

Leading farm machine manufacturers like Moline are quick to recognize the advantages Whitney MSL *lubricated-for-life* Chain can bring to their equipment.

By installing MSL Chain in the new series Moline Grain Drills, the company is making certain that users won't be troubled with chain drive problems.

Whitney MSL Chain contains all the lubricant it will ever need—regardless of the dust, dirt, and hard service it is put through. Oil-impregnated, Sintered Steel Bushings release a constant supply of lubricant under the heat and pressure of operation . . . and reabsorb the oil when the drive stops, to ensure a permanent oil supply for the life of the chain. All 3 critical areas—pin, plates, and sprocket engagement—are protected by a film of oil that lubricates thoroughly and minimizes wear.

For exceptional drive chain performance, long life, and less maintenance, specify and use Whitney MSL Chain. All essential dimensions conform fully to ASA Standards for complete interchangeability with any similar pitch chain. MSL Chain is available in Standard and Double Pitch Series and Conveyor Type CA Series.

*Maximum Service Life

Write for MSL Chain Catalog today.

THE WHITNEY CHAIN COMPANY

a subsidiary of FOOTE BROS. GEAR AND MACHINE CORPORATION

4567 S. Western Blvd., Chicago 9, Ill.

POWER TRANSMISSION DRIVES

Circle 587 on Page 19

America's First cO-Mpact Cylinder

INTERNAL KEY
TIE-RODLESS-TYPE SERIES 101A

Air 150 psi—Hydraulic up to 1500 psi
Fits where others won't
Meets JIC Standards, Bulletin 101A

This original space-saving cylinder is the most compact, streamlined and versatile cylinder available. It requires one-third less installation space and has a greater ratio of power to its size and weight than tie-rod-type cylinders with the same bore and psi rating. In addition, the ports can be rotated independently to any convenient location. It is easier to service. And by using a majority of standard parts and one or two semi-standard parts, this component gives you the advantage of special cylinders that do a better job at a nominal cost.

This compact unit has the lowest coefficient of friction. It is designed right to seal right . . . to make full-power starts on thrust and return strokes . . . to maintain perfect rod alignment . . . and cushion piston shocks. End plugs are tapped for universal mounting.

Coupon below brings Bulletin desired.

Bulletin 101A for Internal Key Tie-Rodless type Air and Hydraulic Cylinders featured above.

Bulletin 105A—Improved Tie-Rod (Heavy Duty) Cylinders Hydraulic 2000 psi; 3000 psi non-shock.

Bulletin 107—Automation (Heavy Duty) Air Cylinder for 200 psi operation.

Bulletin 108—Automation (Heavy Duty) Hydraulic Cylinder—for 1000 psi operation.

All O-M Cylinders are available in 1½" to 8" bores with standard or heavy-duty rods. Complete line of mounts and interchangeable parts. Immediate delivery on most sizes. **MAIL COUPON TODAY.**

ORTMAN-MILLER MACHINE COMPANY
7 143rd Street, Hammond, Indiana
Send Bulletins
☐ Have representative call ☐ 101A ☐ 107 ☐ 105A ☐ 108

Name_____ Position_____
Company_____
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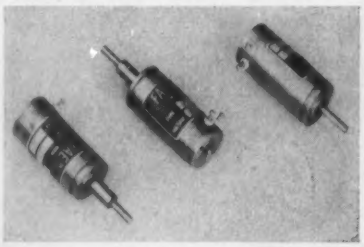
City_____ Zone____ State_____

Circle 588 on Page 19



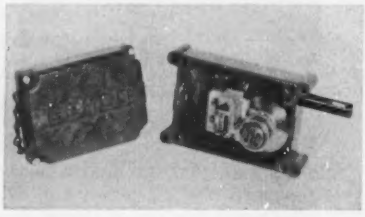
vironmental specifications. **Fae Instrument Corp.**, 42-61 Hunter St., Long Island City 1, N. Y.

Circle 780 on Page 19

Rotary Limit Switch

has four switches and four adjustable cams

Compact four-circuit rotary limit switch is used for machine tools, handling devices, and rotary operators where motion is expressed in shaft rotation. Unit features four switches and four independently adjustable cams. Housed in a NEMA 1 enclosure, unit measures only 3½ in. wide x 5 1/2 in. long x 2½ in. high. Case is glass fiber, highly resistant to acids, alcohols, hydrocarbons, and heat. Each circuit has a single-pole, double-throw switch with isolated contacts that are rated at 5 amp, 115 and 250 v ac, and 3 amp, 30 v dc. Cam arrangements from 25 to 335 deg in approximately 20-deg steps are available, along with 15 different gear ratios as standard ranging from 5:1 to 1000:1. **Gemco Electric Co.**, 25685 W. Eight Mile Rd., Detroit 40, Mich.



Circle 781 on Page 19

Universal Connectors

have removable precision centering hardware

Universal electronic and electric connectors are designed for solderless installation. Typical of the devices are MS-type connectors em-

PROTECT THE PRECISION

...you build into your products

with low cost LISLE *Magnetic* PLUGS

Many leading manufacturers increase the life and reliability of their products by installing Lisle Magnetic Plugs instead of ordinary drain plugs in any system where moving parts operate in a fluid.

The Lisle Magnetic Plug pulls out ferrous metal particles circulating in the fluid.

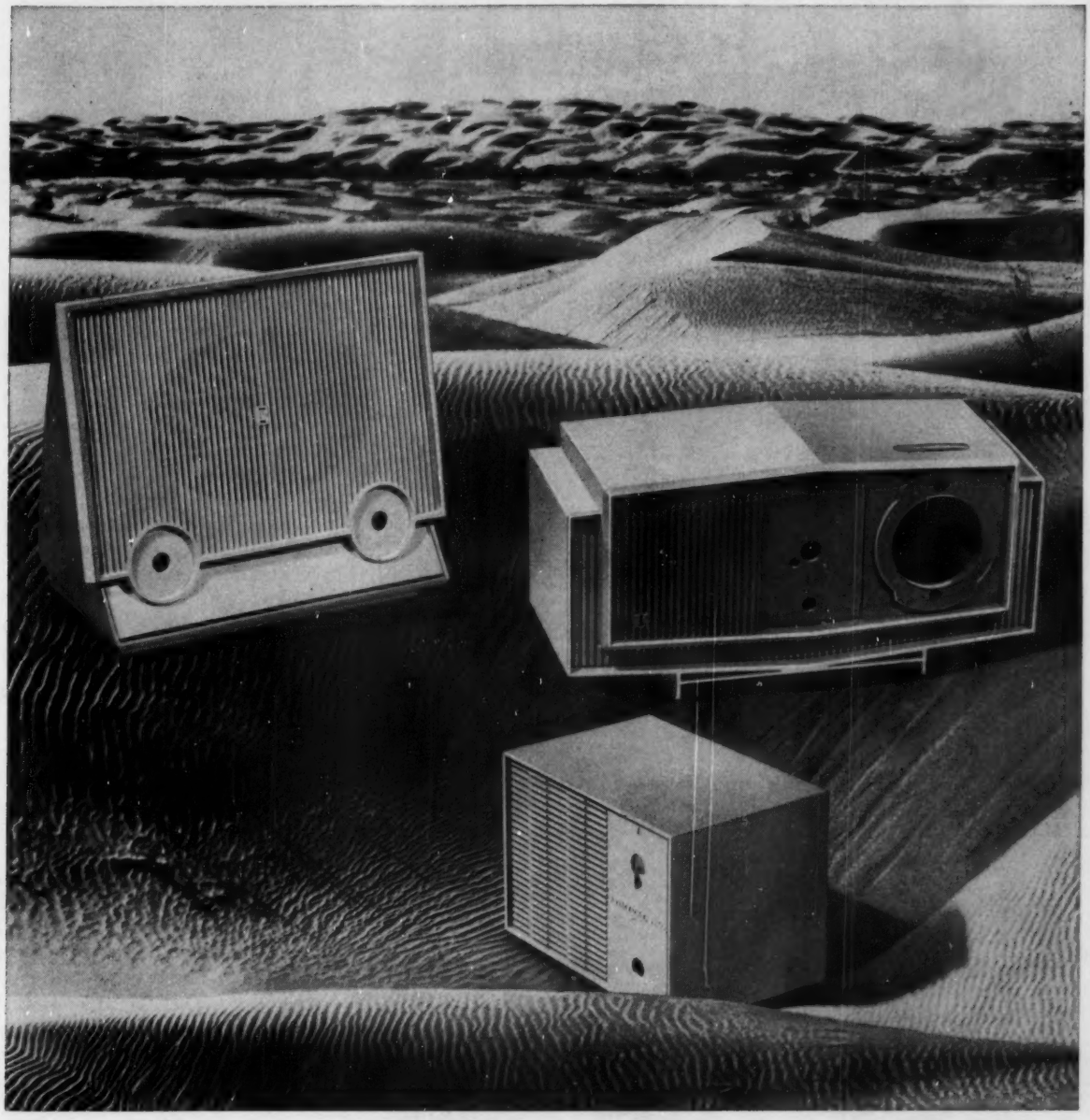
Tests conducted by Lisle Magnetic Plug **users** have proved its effectiveness — some more than doubling the service-free life of their products.

FREE Samples for Testing in Your Product

LISLE CORPORATION
Clarinda, Iowa

Circle 589 on Page 19

This new plastic gives radios a strong case against heat!



Koppers has developed a new high heat resistant material . . . DYLENE® 9 polystyrene . . . a natural for radio cabinets. This new formulation was developed to meet industry's need for a material with increased heat resistance. The radio cabinets pictured above are molded of this new plastic, and they've passed rigid oven tests.

Quality radio manufacturers choose new DYLENE 9 because it resists heat and molds easily. The finished DYLENE cabinets illustrated meet all the requirements of the Underwriters Laboratory. And despite its increased heat resistance, DYLENE 9 does not require special molding equipment.

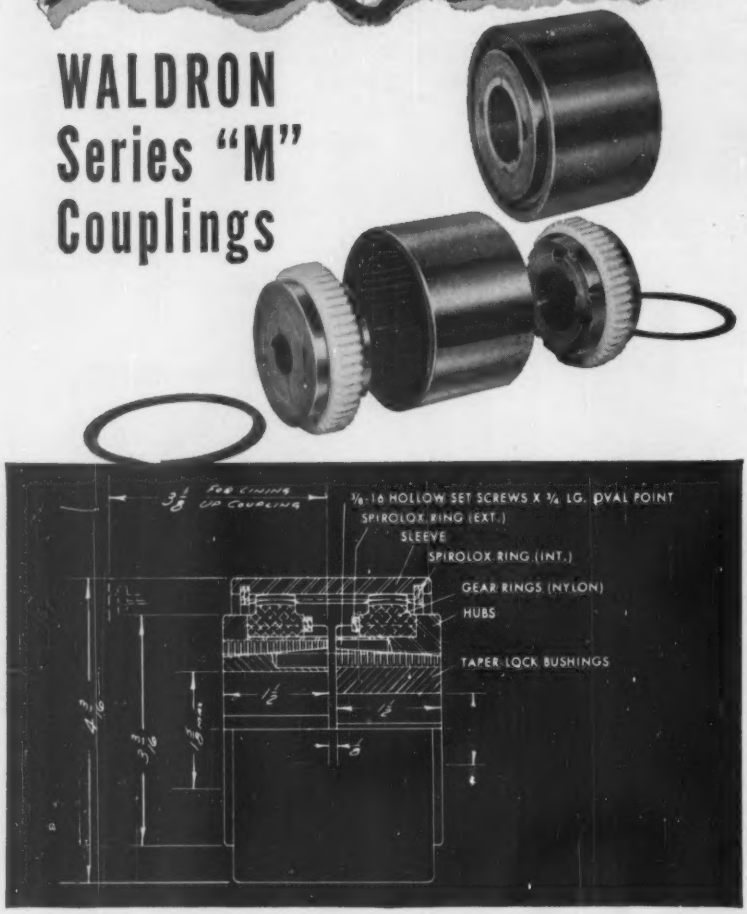
For more information on DYLENE 9 and its applications write to Koppers Company, Inc., Plastics Division, Dept. MD11100, Pittsburgh 19, Penna. Koppers also makes these other fine plastics; DYLAN® polyethylene, SUPER DYLAN® high density polyethylene and DYLITE® expandable polystyrene.

KOPPERS PLASTICS

Circle 590 on Page 19

design facts....on

WALDRON
Series "M"
Couplings

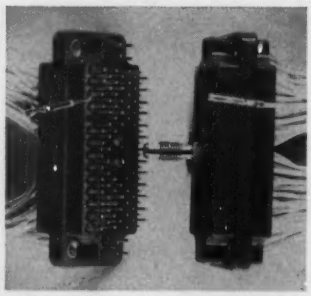


The new Series M couplings—with nylon gears and steel sleeves—need no lubrication. Equipped with Taper-Lock bushings—each coupling size can accommodate a range of shaft sizes. For instance, the 162M, now available, will take shafts from ½" to 1⅝" with proper size Taper-Lock bushings, and up to 2" without the bushings. Hubs are machined from bar stock and the one piece sleeve is made of steel. This design means a smaller, light weight coupling that is easier to install and maintain and yet can transmit the necessary power. Size 162, Series M gear couplings can be used for continuous operation up to 5000 rpm at torques up to approximately 2000 inch pounds.

WRITE FOR CATALOG

WALDRON Couplings

WALDRON-HARTIG DIVISION
MIDLAND-ROSS CORPORATION
BOX 791, NEW BRUNSWICK, N. J.



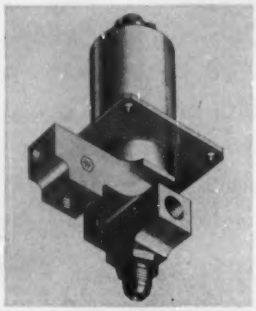
ploying removable pins and sockets. Various standard configurations of basic connectors, pins, and sockets are available to accommodate wire gages No. 8 through No. 22 and also coaxial cables. Connectors feature removable precision centering hardware. They also have identical, interchangeable, plastic connector body halves for perfect alignment and mating, plus positive electrical connections through all pins and sockets. **Industrial Systems Div., Hughes Aircraft Co.,** P. O. Box 90904 Airport Station, Los Angeles 45, Calif.

Circle 782 on Page 19

Directional-Control Valve

for use with helium and other gases

Three-way cryogenic directional-control valve specifically developed for use with helium has exceptional sealing properties which permit its use without modification with any other gas. The solenoid-operated valve has a total weight of only 1.78 lb. Lightweight aluminum body incorporates an optional inlet port connection. Insulation is not required with the valve, which operates at temperatures from −320 to +165 F. Unit withstands shock and vibration. Choice of end fittings for flared or flareless tubing



Circle 591 on Page 19

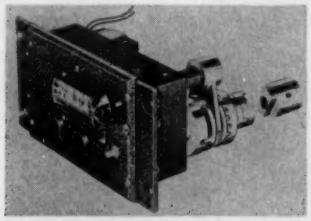
is available in sizes from ¼ to ½ in. Special Products Div., Weatherhead Co., 300 E. 131st St., Cleveland, 8, Ohio.

Circle 783 on Page 19

Digital Indicator

has built-in dial illumination

Model 5-SM-7558 panel-mounted, high-speed digital position indicator has built-in illumination of the dial. Soft, glareless lighting is provided by two 24-v ac bulbs, replaceable from the front of the panel. Electrical connections for the lighting are made directly to 115-v, 60-cycle, alternating current,



through a terminal strip on the back of the counter and transformer for reduction to 24 v ac. Unit incorporates ball bearings and high-speed nylon wheels and pinions to count at rates to 15,000 counts per minute with standard 10:1 ratio. Counter measures and reads to 0.001 or 0.0001 in. Magnifying lens enlarges the figures to ½ in. Clutch is provided so that disengagement can be made from the driving shaft for purposes of easy adjustment and recalibration of the machine. Durant Mfg. Co., 1933 N. Buffum St., Milwaukee 1, Wis.

Circle 784 on Page 19

Epoxy Adhesive

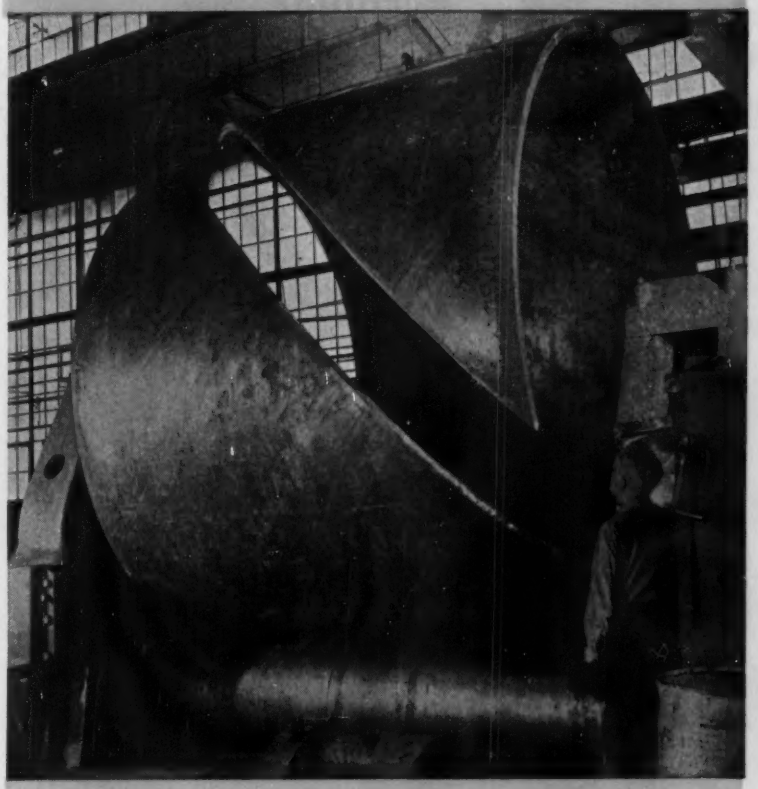
is high-strength, two-component system

Maraset resin 533A is a two-component, contact-pressure epoxy adhesive that can be cured at room temperature to provide high bond strength. Resin is furnished as a solvent-free, nonvolatile, medium-thick paste with a two-hour pot life. Adhesive is intended primarily to join together aluminum, steel, brass, copper, magnesium, and combina-

AMPCO®

BIG BRONZE PLATE!

Varying dimensions—
up to 10,000 lbs. in weight



Here's an idea of what you can get in

AMPCO® metal

A single Ampco metal plate can be big enough (½" x 192" x 360") to form a tank 16' high x 11'-6" diameter! Big enough (1" x 180" x 240") to form a tank 15' long x 5'3" diameter!

An Ampco metal tube sheet 2" thick can be rolled 10'-6" in diameter. One 3" thick can be 9'-0" in diameter.

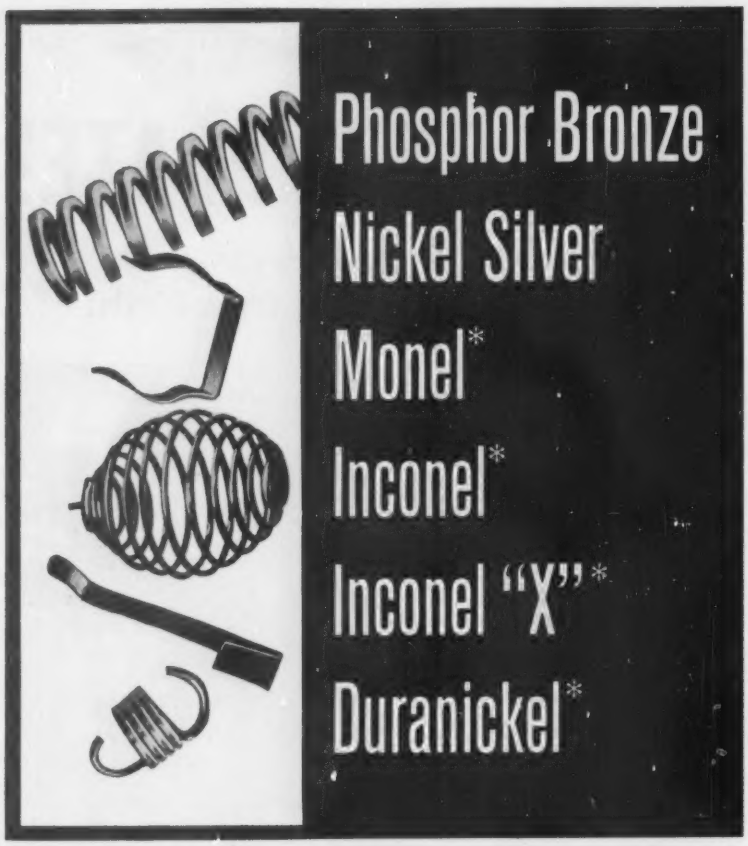
What are *your* requirements for corrosion, abrasion, or mechanical service? Talk it over with your Ampco field engineer. Write for bulletin.

G-32C

AMPCO metal

AMPCO METAL, INC.
Dept. 30K, Milwaukee 46, Wis.
West Coast Div.: Huntington Park, Calif.
Southwest Div.: Garland (Dallas County), Texas

Circle 592 on Page 19



...and now ISOLOY stainless steel spring wire—all from RIVERSIDE-ALLOY

Riverside-Alloy Metal is your *one* source of the world's finest, most uniform spring material . . . round or flat. And now, we add ISOLOY stainless steel!

Stainless is *not* a new material for Riverside-Alloy. But ISOLOY *is* a new trade name. The name ISOLOY was coined so that on specifications you can differentiate Riverside-Alloy stainless spring wire from wires made to conventional standards of uniformity. Regardless of test or comparison, ISOLOY exhibits uniform temper, dimensional size, grain size, tensile strength and coating.

Check it now. For complete information, prices and delivery of ISOLOY or other spring materials and a copy of the new "Spring Materials Digest," write: *Riverside-Alloy Metal Division, H. K. Porter Company, Inc., Riverside, N.J.*

*Trademark of the International Nickel Co., Inc.

RIVERSIDE-ALLOY PORTER METAL DIVISION

H.K.PORTER COMPANY, INC.

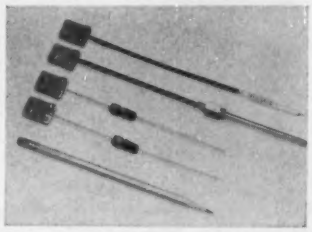
PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

tions of these metals. It is also used to bond wood, glass, rubber, and plastics (except polyethylene, vinyl, and Teflon), as well as reinforced plastics such as laminates of polyester and fibrous glass. Resin creates a durable bond that will not delaminate under heavy duty. Properties include low shrinkage, resistance to mechanical and thermal shock, high creep resistance under constant stress, low moisture absorption, and good resistance to water, chemicals, oils, solvents, and aromatic fuels. **Marblette Corp.**, 37-31 Thirtieth St., Long Island City 1, N. Y.

Circle 785 on Page 19

Miniaturized Thermocouple

operates in 2000 F temperature



Thrift Therm is a miniaturized, low-priced thermocouple assembly with adaptability covering virtually the entire range of thermocouple temperature-sensing applications. Unit provides temperature measurement of any medium-gases, liquids, semisolids. It has a temperature range from 0 to +2000 F. Unit is small enough and flexible enough for multiple application in small spaces. Units are available in chromel-alumel, iron constantan, or copper constantan. **Dept. TT, Harco Laboratories Inc.**, 77 Olive St., New Haven, Conn.

Circle 786 on Page 19

Variable-Speed Pulleys

for heavy-duty drives to ½ hp rating

Molded nylon glass-fiber pulleys, Model MP, are combined with metal-reinforced inside flanges in improved heavy-duty components. Pulleys have a 2.45:1 infinitely variable speed range, spring-loaded tension, and ⅜ to ⅝-in. solid or hollow-shaft bores. Addition of

Circle 593 on Page 19

When dependable electric power is the lifeblood of your equipment

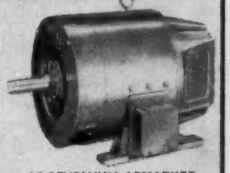
Specify Onan Generators. Rugged, reliable, all-climate. Built by the world's leading builder of generator sets.

Off-shelf, modified or custom designed models

You'll never have to settle for an "almost as good" generator from Onan, because we'll modify or custom design to fit your exact requirements. Solving electric power problems has been our specialty for more than 30 years—more skill and experience at Onan than you can get from any other source.

Tell us your AC or DC power needs, for (1) general use, such as construction or agricultural equipment, (2) magnet use, or (3) battery charging. Whether direct from stock, modified or custom designed—Onan generators will fit your special requirements best.

TYPICAL ONAN GENERATORS AVAILABLE FROM STOCK

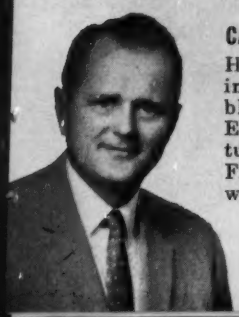


AC REVOLVING ARMATURE: 1½ to 10 KW.

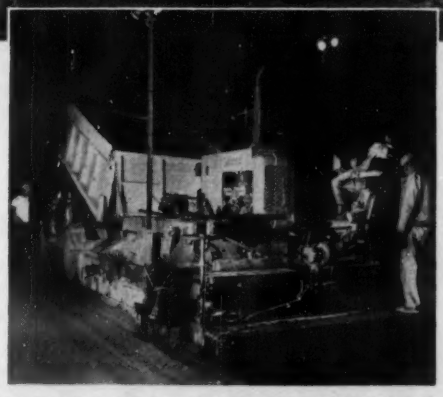
KW RATINGS	A-C		D-C	
60-cycle 1800 rpm	1½, 2½, 4, 7, 10			
50-cycle 1500 rpm	2, 3, 5, 8,			
general use, 1750 rpm			2, 5	
magnet use, 1750 rpm			10, 15	
Battery chargers			1½, 2, 3, 5	
Dimensions, approx. inch	min.	max.	min.	max.
height, inc. ring	13¾	18	17½	17½
length, inc. shaft	16⅝	26⅛	24	25⅞
width	11½	15¼	17⅜	17⅜
Weights, approx. lb.	100	400	115	400
Also available 4, 7, 12 KW. PTO generators.				

ALL THESE SPECIAL FEATURES ARE STANDARD ON ONAN

- Heavy-duty rolled steel frames
- Laminated, balanced armatures
- Form wound, fully-taped field coils
- All-climate insulation
- Drip proof
- Ball bearing construction
- Rotate either direction
- Conservatively rated



CALL BOB WESTRUM. He's an expert in solving generator problems for Original Equipment Manufacturers. Minneapolis, FEderal 2-1155. Or write.



ELECTRIC POWER ON THE MOVE! Versatile 120-240 volt, 60-cycle, single phase Onan Generator powers both the heater burner and screen vibrators on this bituminous road paver. What's *your* electric power problem? Let Onan help!

BIG PICKUP! Plenty of lifting power here with Onan's specially designed Generator for electro-magnet service. Steady, reliable power assures maximum payload every time. Electrify *your* equipment with its main engine and an Onan Generator.

WORLD'S LEADING BUILDER OF GENERATOR SETS

Onan®

D.W. ONAN & SONS INC
2920 University Ave. S. E.
Minneapolis 14, Minnesota

Circle 594 on Page 19

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for processing compressed air

Filter-Regulator Combination Units

Type 73AB
⅛" pipe size.

Manual-Drain Compressed-Air Filter

Model 30AJ-1—⅛" pipe size.

Pressure Regulators

Type 20AR—for air, water, oil and similar fluids—⅛" and ¼" pipe sizes.

Diaphragm-Type Relief Valves

Type 40AB—for air, water, oil and similar fluids—⅛" and ¼" pipe sizes.

Automatic-Drain Compressed-Air Filter

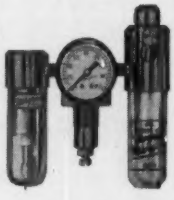
Model 30BJ-1
⅛" pipe size.

Micro-Fog Lubricators

Model 10AG-1L—lubricates air-operated equipment and machine bearings.

Model 10AH-1L—lubricates air-operated equipment.

Both models ⅛" pipe size.



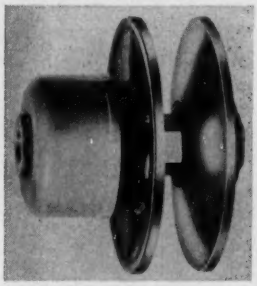
Micro-Fog Lubro-Control Units

The new Norgren compact units may be used singly or in combination. Illustrated is a lubro-control unit made up of a 30AJ-1 filter, 20AR-1GG regulator and 10AH-1L lubricator—⅛" pipe size.

Norgren compact units give you big performance in small space. For complete information on the complete line of Norgren filters, regulators and lubricators in all sizes, call your nearby Norgren Distributor, listed at left—or write for brochure NA-3.

C. A. NORGREN CO. FOUNDED IN 1926

3442 SOUTH ELATI STREET • ENGLEWOOD, COLORADO



metal-reinforced flanges provides higher heat and abrasion resistance, and longer service life in severe applications. Three sizes are available for 1/4, 3/8, and 1/2-in. V-belt drives to 1/2 hp. **Rampe Mfg. Co.**, 14915 Woodworth Ave., Cleveland 10, Ohio.

Circle 787 on Page 19

Noninflammable Lubricant

for high-temperature, high-pressure use

Surf-Kote L-1020 is a new lubricant containing a modified molybdenum-disulfide compound and other additives supended in a synthetic base vehicle. Vehicle evaporates and leaves a durable, dry film of solid lubricating compound on most metal surfaces, preventing galling, seizing, fretting corrosion, cold welding, and similar friction problems. Lubricant is formulated for use under high-pressure, high-temperature conditions to 750 F. It is applied directly to load-bearing surfaces or through grease cups and zerk fittings with hand oilers, an oil can, or by brushing. **Hohman Plating & Mfg. Co.**, 814 Vermont Ave., Dayton 4, Ohio.

Circle 788 on Page 19

Slide Switch

triple-pole unit is rated at 3 amp

Type SW-369 slide switch has a triple-pole, double-throw circuit. Switch finds use in many applications in audio systems, electronic measuring devices, home appliances, and industrial controls. It is rated at 3 amp, 125 v ac-dc, and similar models are available in other current ratings. For easy assembly in end products, switch has all terminals in a common plane, per-

"I owe my success to my trusty Sigma Type 22 RJC200G SIL relay"

— PORTHOS P. GIZZARD

With a sizable amount of our business due to saber-rattling on a national scale, it's heartening to discover some relay prospects among those who practice skewering each other just for fun. One of our reps recently wrote in, calling our attention to a device in which a buzzer sounds when a proper forward-moving fencing "hit" is scored. The buzzer circuit is closed by the contacts of a Sigma "22" relay, which in turn is wired to a battery and a plunger switch at the tip of the foil or épée. The inventor's name is L. A. Wortman, and he holds no lesser rank than chairman of the Electrical Weapons Committee of the Amateur Fencers League of America, as well as American Delegate to the Electrical Signaling Comm., Federation International D'Escrime.

We sincerely hope, however, that Mr. Wortman shows more mercy in a *salle d' armes* than he does to the hermetically sealed enclosure of his Sigma sensitive relay. In describing his ingenious boon to practice fencers (fencing practicers?), he calmly states "The relay is a Sigma Type 22J200 or equivalent... (These dual series) coils must be separated and reconnected ...The case of the relay is easily removed with a pair of diagonal wire cutters. Starting at the bottom edge and peeling, the cover comes off as though it were a sardine-can cover." *Really*, Mr. Wortman. If Series 22 relay enclosures were meant to be removable, we would have made them that way. (On second thought, maybe supplying a little key with each hermetically sealed Sigma relay might not be such a bad idea at that. Remember that Air Force captain and his little drill?)

At all events, this clearly points out one fact: clever people are still successfully applying Sigma relays in ways which turn our application engineers green (92 parts horror, 8 parts envy). We can only hope that future builders of electrical fencing instruments and kindred souls will first ask us if we have what they want, before picking up the side-cutting pliers. It might pleasantly surprise some to see the assortment of open and sealed, single- or dual-coil, magnetic latching, big and little relays we can offer. We might even have one for Mr. Wortman's august body which would signal a hit not by a buzz on a buzzer, but simply by saying "ouch."

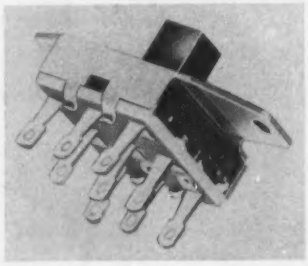
"22" Bulletin on request; application engineering by letter and over the phone.

SIGMA

SIGMA INSTRUMENTS, INC.
89 Pearl Street, So. Braintree 85, Mass.

An Affiliate of The Fisher-Pierce Co. (since 1939)

Circle 596 on Page 19



mitting a more convenient fit in the chassis and avoiding short circuits. Switch requires less than 0.6 cu in. space. It has clearance-type mounting holes on 1⅝-in. centers. Switch is integral in one frame, with one actuating knob. **Continental-Wirt Electronics Corp.**, 26 W. Queen Lane, Philadelphia 44, Pa.

Circle 789 on Page 19

Insulating Tape

is Teflon FEP and glass cloth

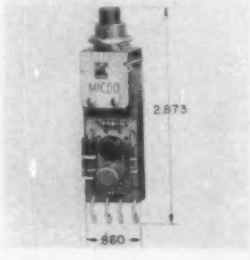
Lamoflex Type TG insulating tape, for use in electrical equipment, transformers, and motor coils, is constructed of Teflon FEP on one side of a glass-cloth reinforcement. Both thickness of Teflon and type of glass cloth can be varied. First of the series has 0.002-in. Teflon FEP on 0.002-in. glass cloth. Available in widths from ½ to 6 in., one of its prime uses is in the wrapping of motor coils. **International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa.

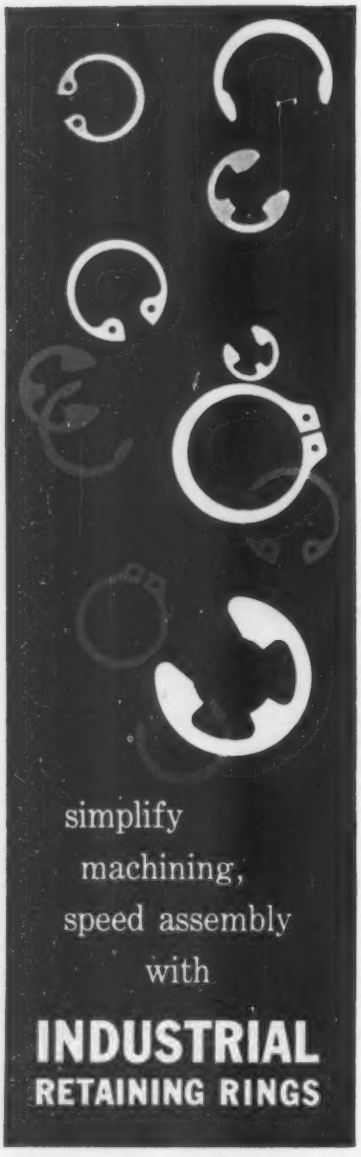
Circle 790 on Page 19

Electronic Switches

for use with high-speed electronic components

Four bounce-free electronic switches are designed to eliminate spurious voltage pulses caused by contact bounce. Devices include a compact





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Eliminate costly tooling and machining ...speed assembly...by using precision-made INDUSTRIAL Retaining Rings. Available for immediate delivery in types, finishes and sizes exactly right for your job.

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**Also available stacked for speedier application.*

All series except 2000 available bowed for resilient take-up of end play.

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Originators of modern retaining ring dispensing.

INDUSTRIAL RETAINING RING CO.

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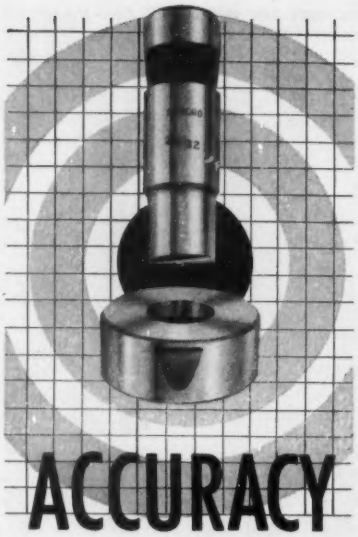
Circle 597 on Page 19



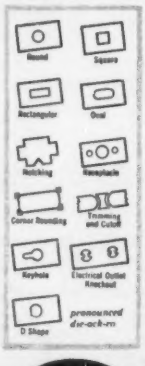
ACCURACY ASSURED

WITH DI-ACRO PRECISION PUNCHES AND DIES

Immediate Delivery from factory stock

Accurate hole location is easily achieved with Di-Acro Precision Punch and Die sets because the centering point on the punch is ground concentric to the cutting edges, there is no "slop" even when several holes are punched in a blank. Hole sizes are accurate due both to the high degree of concentricity of the punch and die set and the choice of clearance which allows you to obtain clean, burr free holes no matter what material thickness is to be perforated. All Di-Acro punches and dies are precision made of high quality tool steel.

For multiple hole punching ask us about the new Di-Acro Adjustable Punches and Dies.



Over 500 standard sizes of Di-Acro Precision Punches and Dies in 12 standard styles are stocked. Punch Adapters and Die Holders are available to fit all styles of punch presses.

For extra convenience and savings order Di-Acro Punch Paks—fitted steel chests containing 24 and 30 sets of punches and dies.

Consult phone book Yellow Pages under Machinery—Machine Tools for your Di-Acro distributor or write for catalog and prices.

di-acro PRECISION METALWORKING EQUIPMENT

O'NEIL-IRWIN MFG. CO.

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Lake City, Minnesota

Circle 598 on Page 19

Available NOW...ready to attach S.S. White Standard Flexible Shafts

A complete flexible shaft package is available *in stock*... ready to attach to your mating spindles ...S. S. White *standard* flexible shafts.

Use them to simplify existing equipment or to make low-cost tests on prototypes. You are ahead of the game with standard flexible shafts, because the designing has already been done for you by S. S. White, first name in flexible shafts.

You can get them in a hurry too. S. S. White carries a complete stock in shaft sizes from .150" to .500" in diameter. *Power drive* flexible shafts for high speed, continuous operation... or *remote control* shafts for operation in either rotational direction. Rugged neoprene casings and standardized couplings that eliminate the need for special connectors.

Start now toward more freedom in your designing. Eliminate cumbersome solid drives, gears, universals. Eliminate shock and vibration problems. Investigate time- and money-saving S. S. White flexible shafts.

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THE S. S. WHITE FLEXIBLE SHAFT HANDBOOK
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FIRST NAME
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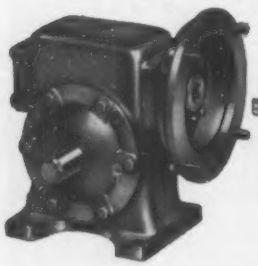
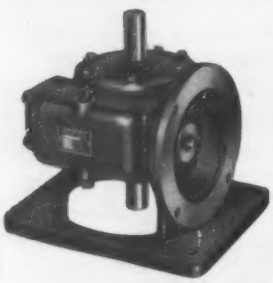
956
different
motorized
speed reducers

available from stock

Yes! 956 different combinations of Perfection Motorized Worm Gear Speed Reducers are available for immediate delivery, *from stock.* Ratios range from 5 to 1 to 60 to 1, in capacities from 1/6 H.P. to 5 H.P. Perfection "C" Flange Reducers may be ordered complete with motor or without motor, to be used with a motor *of your own choice.*





Flanged motor reducers offer the maximum in compactness, rigidity and adaptability. Through the use of standard NEMA face mounted motors, complete interchangeability between motors is provided. Motor maintenance is possible without disturbing the drive and reducer. Motor assembly is fast and positive with no alignment problems.

Write for your free copy of our new 28 page catalog containing illustrations, charts and tables to help you choose the right Reducer for your particular application. Ask for Bulletin No. M-140.

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AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY, HARVEY, ILLINOIS

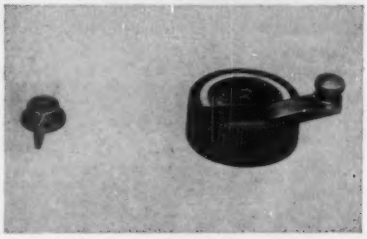
circuit package with the mechanical switch to produce a pulse-free voltage output in pulse and digital systems. Switches are for use with high-speed electronic components that operate in less than 1 microsec. One of the switches produces a positive voltage output with resistive loads from 100 to 500 ohms; another produces a positive voltage output from resistive loads over 500 ohms; the other two produce negative output voltages with these same resistive loads. **Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.**

Circle 791 on Page 19

Knobs

for military use

MS 91522, MS 91523, and MS 91524 knobs are made of zinc or aluminum. They are painted olive drab per Spec 72-53 or Navy Gray per Spec P513, both with phosphores-



cent paint per Spec TT-P54 in index groove. Knobs are used on AN/GRC, AN/PRC, AN/TRC, and AN/VRC equipment. **Vemaline Products Co., 511 Commerce St., Frankline Lakes, N. J.**

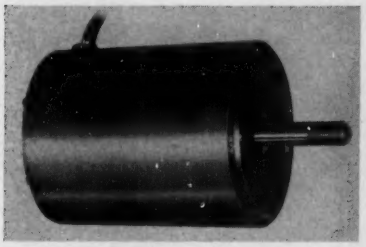
Circle 792 on Page 19

Induction Motor

drives an axial vane blower

DE-20-6 axial vane blower induction motor is designed specifically to drive an axial vane blower but can also be used in many other military and commercial applications. Constructed of corrosion-resistant material, it provides efficient operation despite exposure to severe environments. Motor also features a high power factor and is qualified according to the applicable portions of MIL-M-7969 and MIL-E-5272. The 3.4-hp unit has an op-

Circle 600 on Page 19



erating speed of 11,500 rpm. **Kearfott Div., General Precision Inc.**, 1150 McBride Ave., Little Falls, N. J.

Circle 793 on Page 19

Porous-Metal Parts

in complex shapes and flat stock

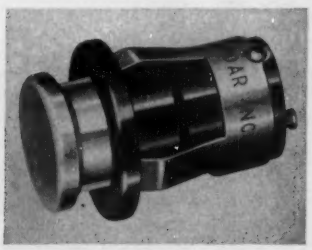
New refined process permits the obtaining of controlled porosity in stainless steel, iron-nickel alloys, and other high-temperature metals. Complex shapes as well as flat stock can be manufactured and reproduced with high precision assured by control over pore size, pore distribution, ductility, liquid and air permeability, and related physical or mechanical properties. Materials can be multilayered, sized, alloyed or impregnated; finished products can be welded, brazed, soldered, formed, or machined. **Mott Metallurgical Corp.**, 272 Huyshope Ave., Hartford, Conn.

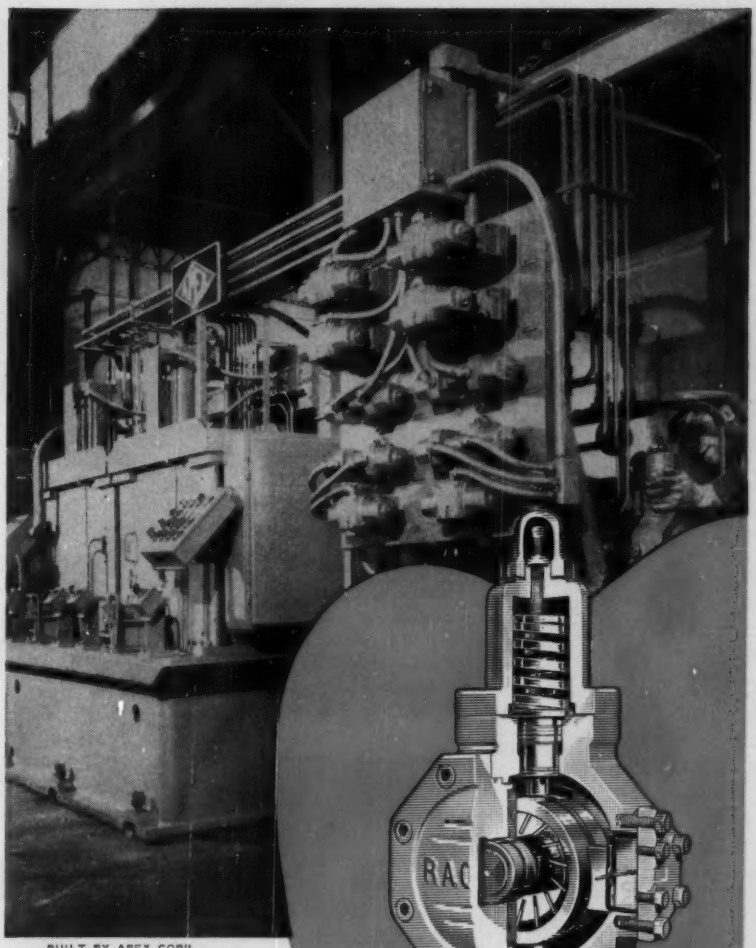
Circle 794 on Page 19

Indicator Switch Light

for use on keyboard devices

Low-current, long-life, fast-acting indicator switch light, Type 2717, has broad application in all types of keyboard devices and wherever momentary fingertip-control switching is required. Device can be installed from the front of the panel. It is retained in position by a three-point pressure-mounting hole. If en-





BUILT BY APEX CORP., ROSEVILLE, MICHIGAN

This active hydraulic heart helps

SEAL POROSITY IN 106 TRANSMISSION CASES EVERY HOUR

A RACINE VARIABLE VOLUME PUMP and 10 RACINE VALVES control *all* mechanical operations in this Apex impregnating machine, which seals leaky transmission cases at a major auto firm's transmission plant in Toledo, Ohio. Apex specified RACINE equipment because its design simplifies machine design problems . . . eliminates the need for extra pumps and valves. RACINE PUMPS are easy-to-control . . . handle pressure compensation *automatically* for varying gpm requirements. Apex has *preferred* RACINE for over 10 years!

the HEART of this impregnating machine is a RACINE MODEL 6FA PUMP

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

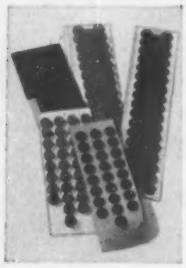
HYDRAULICS DIVISION

Circle 601 on Page 19

Can These
FELT
BY FELTERS
IDEAS
Help You?

FELT GREATLY REDUCES GLAZING COSTS

over conventional brushing. Fine china manufacturer uses special Felters DuFelt Polishing Belt to reduce glazing costs. Felt coarseness and density can be varied for most effective polishing of metal, glass and ceramics. Can also be coated with abrasives.



FELT ADHESIVE TAPES AND PADS

are the most inexpensive material for sealing, padding and cushioning. Felt strips seal out dust, dirt, wind, fumes, moisture, and eliminate squeaks and rattles.

FELT AS A LOW COST FRICTION MATERIAL

Used as a braking or friction device, sometimes combined as a seal or washer. High coefficient of friction and extra density provide foolproof clutching and tension action at low cost, like the Lever Puller shown at left.

To get the most out of Felt, send for the Felters Design Book — a complete digest on properties and applications. Write, today.

Ask for **FELT** *from . . .*

The **FELTERS** Co.

271 SOUTH STREET
BOSTON 11, MASSACHUSETTS

Pioneer Producers of Felt and Synthetic Non-Woven Fabrics PF 9-14

graved, lens is keyed to prevent turning and embodies snap-in lens lock. Switch can be rebulbed from the front of the panel. **Pendar, Inc.**, 14744 Arminta St., Van Nuys, Calif.

Circle 795 on Page 19

Germanium Transistors

are extremely small units

Germanium subminiature transistors are 21 times smaller than presently available transistors with the same electrical characteristics. Differing only in size, weight, and dissipation from their larger counterparts, the six subminiatures have maximum ODs of 0.130 by 0.130-in. Collector

dissipation of the new units is 70 mw at 25 C. New transistor (left) is hermetically sealed in a metal case with metal and glass base. **Semiconductor Div., Raytheon Co.**, 200 First Ave., Needham, Mass.

Circle 796 on Page 19

Adjustable-Speed Drives

in sizes from 2-15 hp

No. 111 Syncro-Range drives, ranging in sizes from 2 to 15 hp, provide adjustable speed for synchronous induction motors running in exact synchronism over a wide range of speed. Drive is an integrated system consisting of an adjustable-frequency power supply, one or more Syncro-Spede drive motors, and a control panel. Adjustable-frequency power is supplied from an ac alternator driven by a constant-speed, squirrel-cage induction motor which provides infinitely adjustable speed through mechanical interaction of adjustable discs and a ribbed belt. By adjusting power-supply output, drive motors can be varied in speed over a wide range, maintaining ex-

Circle 602 on Page 19

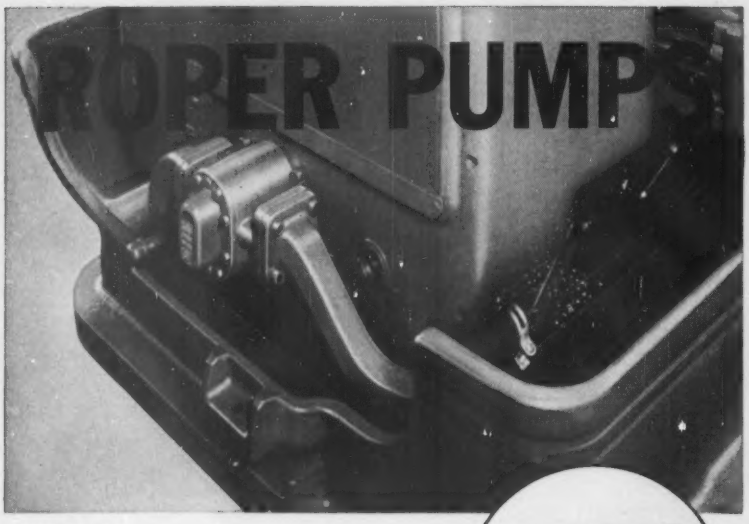
Circle 603 on Page 19→

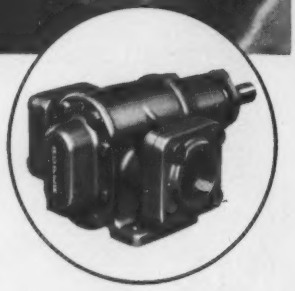
ON THE HIGH COST OF VIBRATION IN AIR MOVING EQUIPMENT

Have you considered the fact that normal excitation in your product can produce resonance and structural failure in the air moving components? We have, and this fact is "pocketbook and problem insurance" for our customers. For instance: We know that motor rotational frequencies ... blade frequencies ... magnetic frequencies ... are basic sources of excitation present in every fan or blower application. When the above coincides with the natural response of the unit, this means resonance and—plenty of trouble. At Torrington, each product of ours is designed, engineered and tested for an optimum range of performance, with harmful or costly resonances "designed out." It pays to know these performance characteristics—and to take advantage of this kind of knowledge. Check your air moving problems or your products with Torrington.

THE TORRINGTON MANUFACTURING COMPANY

AIR MOVING DIVISIONS Torrington, Connecticut; Van Nuys, California; Rochester, Indiana; Oakville, Ontario





SERIES K

adapted to the demands of a wide range of jobs

¾-50 GPM • PRESSURES TO 150 PSI • SPEEDS TO 1740 RPM

Typical of the great adaptability of the compact Roper Series K rotary pump is its service as a coolant pump in supplying soluble and cutting oils to this automatic screw machine. The requirement for instant priming in this machine requires a positive displacement pump. The rugged Series K meets the specifications of many original equipment manufacturers who require dependable, quiet, efficient transfer of clean liquids in hydraulic service, fuel supply duty for large oil burners, or diesel fuel oil transfer. Special fittings for transfer of corrosive liquids and special mountings to meet installation requirements can be supplied. Series K models can be direct connected, chain-, belt-, or gear-driven. Precision construction and thorough individual pre-testing insure its durability of performance. Specify Roper for rugged dependability.

Features behind Series K versatility

● Simplified design . . . only two moving parts ● Smooth flow . . . quiet operation ● Interchangeable mounting brackets . . . easy to install ● Precision-built . . . requires little operating power ● Self-priming . . . high suction lift . . . correct hydraulic principle ● Built-in relief valve . . . adjustable or pre-set.

For information about your specific pump needs, contact your nearest Roper dealer

Send for "How to Solve Pumping Problems" booklet

ROPER HYDRAULICS, INC.

Dependable pumps since 1857

COMMERCE, GEORGIA

act synchronism of all motors at any fixed speed, and also while increasing or decreasing speed. Control panel includes alternator field supply and all necessary controls for proper operation of the drive. **Louis Allis Co.**, 427 E. Steward St., Milwaukee 1, Wis.

Circle 797 on Page 19

Snap-Action Switch

has quick-connect terminals

Designed for office machines, vending machines, electronics, and other sensitive-switch applications, snap-action switch features standard 0.032 x 0.205-in. quick-connect terminals for simple installation and service. The 0.093-in. diam terminal hole also permits soldering to terminal. Coil-spring mechanism

provides for long life, low operating torque, and friction-free blade pivot. Positive overtravel stops and dust-free flange are molded in the case. Unit is rated for 5 amp at 250 v ac. **Cherry Electrical Products Corp.**, 1666 Deerfield Rd., Highland Park, Ill.

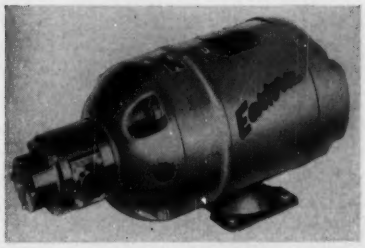
Circle 798 on Page 19

Positive-Displacement Pump

provides pulsation-free flow of nonlubricating liquids

VW-20 vent-type pump is self-priming, and is available in bronze with adjustable bypass, or stainless-steel construction without bypass, stainless steel rotor, composition bearing, and mechanical seal. Unit provides pulsation-free flow of nonlubricating liquids. Maximum pressure for liquids with specific gravities similar to water is 60 psi, and maximum flow is 60 gpm. Furnished with motors in close-coupled

Circle 604 on Page 19



units, models are also available for belt or coupling drive with ball-bearing-equipped stand. **Eastern Industries Inc.**, 100 Skiffs St., Hamden 14, Conn.

Circle 799 on Page 19

Epoxy-Glass Laminate

is self-extinguishing

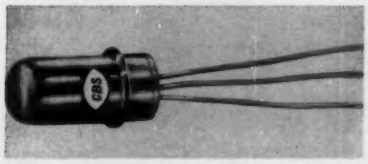
Self-extinguishing G-10 epoxy-glass laminate, Nelco 105, exceeds flame-out requirements of both ASTM and UL tests. Material can be fabricated easily by all standard processes and without causing excessive tool wear. It has all the properties of self-extinguishing G-11 except high flexural-strength retention at elevated temperatures. Laminate is designed for all adverse ambient applications where ruggedness and long life are essential. Laminate has exceptional strength and dimensional stability. It is unaffected by a maximum continuous temperature of 300 F and intermittent temperature of 325 F. Laminate is available in plain or copper-clad sheets up to 36 by 48 in. and in base material thicknesses of 0.010 to 1 in. **New England Laminates Co.**, Stamford, Conn.

Circle 800 on Page 19

Diffused-Base Transistors

feature cadmium junctions for increased dissipation ratings

Micro-alloy diffused-base transistors provide greater speed, efficiency, and performance than competitive devices in low-current switching circuits. Transistors feature cadmium



HILLIARD *Clutches*
FOR POWER CONTROL DESIGN

ADJUSTABLE *Slip Clutch*

- PROTECTS against overload, jams and down time.
- RESUMES THE DRIVE AUTOMATICALLY after overload.
- ELIMINATES SHEAR PINS and lost time.
- ADJUSTABLE - WHILE - RUNNING feature is available.

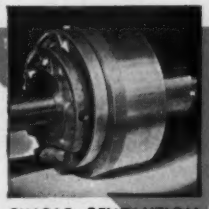
Hilliard Slip Clutches are continuously protecting the drive on dish washing machines—printing presses—packaging machines—case loaders—foundry equipment— air filters—conveyors—overhead doors—and many others.
They maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

The adjustable-while-running types are used to maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

WRITE TODAY FOR BULLETIN 300 WITH COMPLETE INFORMATION.

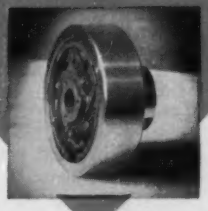
• OTHER HILLIARD CLUTCHES •

CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

SINGLE REVOLUTION CLUTCHES for automatic accurate control —electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.



OVER - RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet, or backstop action. Ask for Bulletin 231.

THE HILLIARD *Corporation*

MANUFACTURING CLUTCHES FOR OVER 50 YEARS

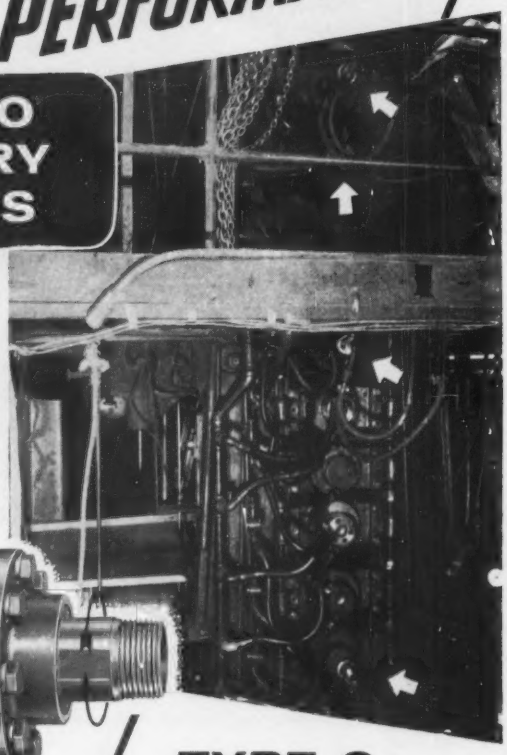
103 WEST FOURTH ST., ELMIRA, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

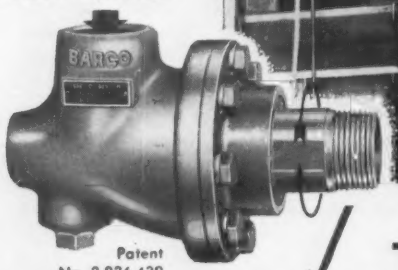
Please direct inquiries to advertiser, mentioning MACHINE DESIGN

OUTSTANDING PERFORMANCE

BARCO ROTARY JOINTS



Shown at the right is an installation of ¾" Barco Type C Rotary Joints on a 9" dia. calender roll stack. Every other roll is equipped to be steam heated and syphon drained at 125 p.s.i., 300°F. The rolls run at a paper speed of 1300 FPM, or approximately 450 RPM. The joints have been in service for many months with no difficulties experienced.



Patent No. 2,836,439

TYPE C

Single Flow or Syphon Flow

- **RESISTS SEAL RING BREAKAGE**—The spherical seal ring is under compression, not *tension*, loading. Self-adjusting for wear. Seal withstands shock loads and alternating hot and cold service.
- **WIDE SPACED BEARINGS**—Two, instead of one . . . increased bearing area. No lubrication required. Lowest friction.
- **200 P.S.I. STEAM RATING**—Heavy duty service at *no extra cost*. Eight sizes, ½" to 3".

HERE is another case (*above installation*) where an experienced user of rotary joints made comparative tests. Two other makes of joints were tried and Barco selected.

"*Last longer without maintenance!*" reports the user. When properly installed, Barco Joints easily withstand rugged service on paper calenders, machines, and other mill equipment.

Barco Type C Joints are available from LOCAL STOCKS throughout the country. Standard series joints handle all steam pressures to 200 psi—one basic style for all services, single flow or syphon flow. *Type CF offered for journal flange connections. ASK FOR INFORMATION.*

SEND FOR CATALOG 310

FOUNDED 1908 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
506M Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

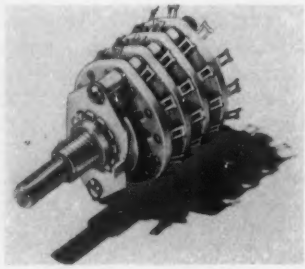
junctions for increased dissipation ratings, and over-all quality exceeding MIL-T-19500A. Transistors are adaptable to simple saturated circuits, offering lower current, voltage, and power requirements. **CBS Electronics Div., Columbia Broadcasting System Inc.**, 100 Endicott St., Danvers, Mass.

Circle 801 on Page 19

Miniature Switches

ceramic units withstand temperatures to 175 C

Miniature ceramic switches use high-temperature alloys and incorporate new assembly techniques that assure operation to 175 C. Cost of these high-temperature switches is approximately four times that of conventional switches. Units pro-



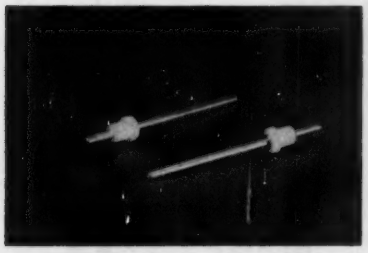
vide up to 22 terminals per section, each insulated from the others, thus frequently eliminating an entire switch section. Maximum switching combinations per section range from 1 pole, 2 to 12 positions, to 6 poles, 2 positions. Voltage breakdown between critical parts is 1500 v rms. **Centralab Div., Globe-Union Inc.**, 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 802 on Page 19

Miniature Feedthrough

for use in chassis of 0.060-in. thickness

FT-SM-1616 subminiature feedthrough has an extra-long pin, permitting extra reach combined with a small-diameter Teflon body for space saving on mounting chassis. Overall length is 0.987 in., while the Teflon body is 0.093 in. diam through chassis, and 0.125 in. diam through mounting shoulder. Unit is designed for use with chassis hav-



ing a maximum thickness of 0.060 in. **Sealectro Corp.**, 610 Fayette Ave., Mamaroneck, N. Y.

Circle 803 on Page 19

DC Blower

produces 90 cfm at 1 in. water back pressure

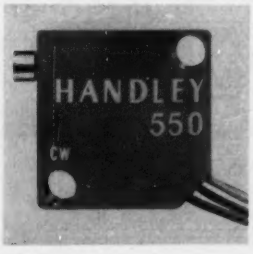
VAX-3-BD vane-axial blower operates from direct current to produce an optimum output of 90 cfm at 1 in. water back pressure. At 28 v dc, maximum current is 1.7 amp at free air delivery; motor windings can be provided for 4 to 115 v dc operation. Precision black-anodized aluminum castings provide adequate environmental protection to meet pertinent MIL specifications. Mounting is made by clamping to servo flange on either end. Life exceeds 500 hr. Dimensions are 3 in. diam by 3-7/64 in. maximum length and weight is 16 oz. **Globe Industries Inc.**, 1784 Stanley Ave., Dayton 4, Ohio.

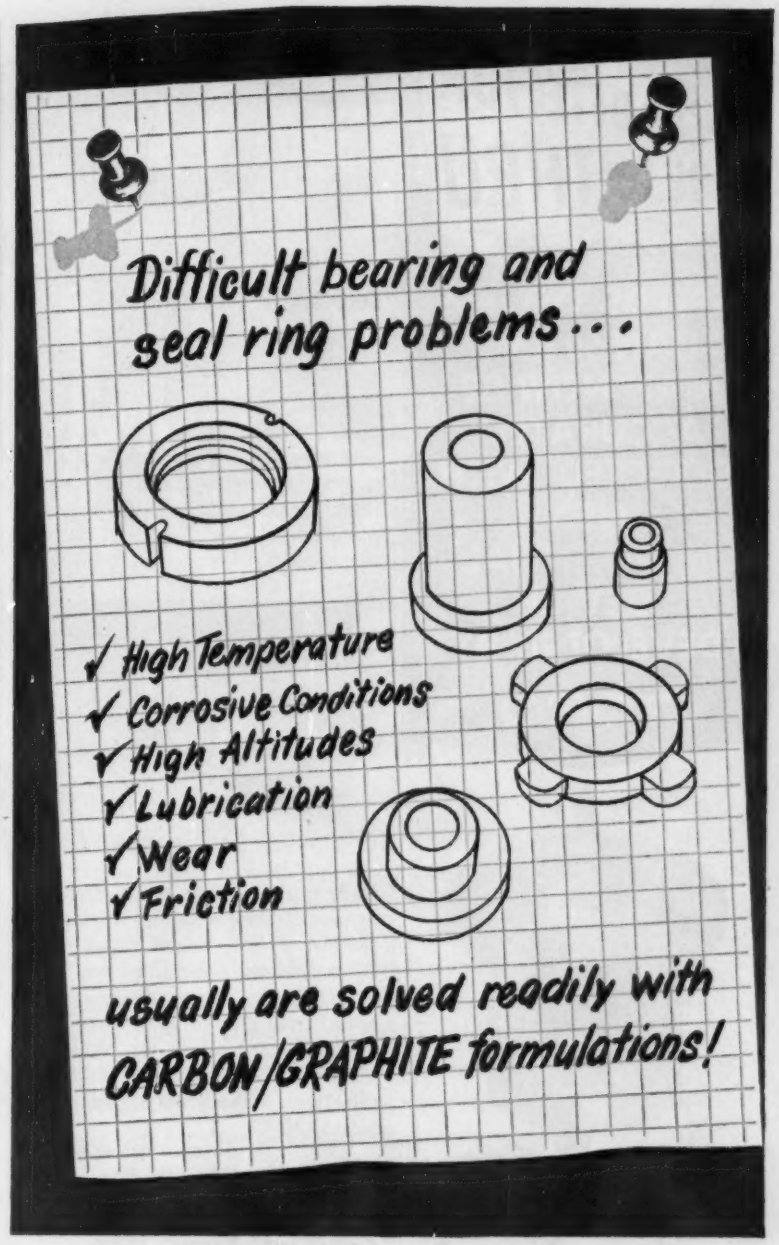
Circle 804 on Page 19

Trimmer Potentiometer

has plastic housing for excellent insulation

Model 550, WeeTrim plastic, 1-w trimmer potentiometer has 6-in. Teflon-covered wire leads. Plastic housing gives excellent insulation, and unit also has superior resolution, dielectric strength, and noise-free operational life. Potentiometer





Many standard grades . . . countless specials . . . with physicals to match your performance requirements exactly. Outline your application for a prompt recommendation. STACKPOLE CARBON CO., St. Marys, Pa.

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Circle 606 on Page 19

SPEED DETECTOR BREAKTHRU

SPEEDS OF LESS THAN 50 R.P.M. CAN NOW BE ACCURATELY DETECTED WITH NEW DIFFERENTIAL DEVICE DEVELOPED BY

TORQ

(Patents & patents pending)

. . . detects 1 to 4 different speeds (high and low limits, or single limit on each circuit). Designed for low speed applications of less than 100 rpm. Inquire about SYNPROTEX DIFFERENTIAL unit for low speeds . . . or standard SYNPROTEX speed detectors for speeds from 100 to more than 15,000 rpm.

TORQ
ENGINEERED PRODUCTS, INC.
26 W. Monroe Street • Bedford, Ohio
Phone: BE 2-4100

Circle 607 on Page 19

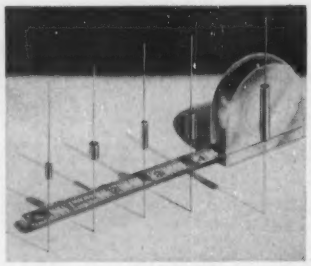
operates to 200 C and protects against humidity and corrosion by sealed isolation of all electrical parts. **Handley Inc.**, 12960 Panama St., Los Angeles 66, Calif.

Circle 805 on Page 19

Subminiature Resistors

have internal flanges to fasten axial leads to body

Designed to MIL-R-93B specifications for operation at ambient temperatures of 125 C, subminiature resistors are encapsulated in epoxy resin for maximum environmental protection. Special internal flanges are used to fasten the axial-wire



leads to the resistor body, guarding against structural failure during assembly or use. Sizes range from $\frac{1}{8}$ to 3/16 in. diam and from $\frac{1}{4}$ to 1 in. long. Power dissipation is scaled from 1/20 to $\frac{1}{2}$ w. Units are designed particularly for computer, missile, and other high-reliability applications. **Shallcross Mfg. Co.**, Selma, N. C.

Circle 806 on Page 19

Centrifugal Pumps

are low-cost industrial units

Series N1000 industrial centrifugal pumps are available both as straight centrifugal or self-priming types. They are furnished either close coupled to electric motor or pedestal mounted for coupling to electric motor, gas, or diesel engines. Units are extremely rugged, with extra bearings incorporated to carry the radial load. Capacities range to 550 gpm and head pressures to 170 ft. Two models are available, with three sizes in each model. They are cast-iron bronze fitted or all

Now in greater lengths

VULCAN
"THUNDERBOLT"
Cartridge Heater

The Vulcan "Thunderbolt" Cartridge Heater is now available in lengths from 1¼" up to 24 inches (or even *longer*) in ⅜", ½" or ⅝" diameters.

The "Thunderbolt" delivers five times more heat than conventional cartridges. Special construction locates insulated resistance wire close to the high temperature alloy sheath. Heat is dissipated rapidly through the sheath without detriment to unit life. Ratings are as high as 40 to 200 watts *per square inch.*

The "Thunderbolt" is ideal for many types of hand and automatic machines that require spot heating. Applications include branding irons, labeling machines, box making machinery, and many others.

Write for new data sheet.

VULCAN
Versatility in Electric Heating
Vulcan Electric Company,
Danvers, Mass.

Circle 608 on Page 19

bronze, with other special materials available upon request. Hydropump Inc., 165 S. Fair Oaks Ave., Pasadena, Calif.

Circle 807 on Page 19

Miniature Potentiometer

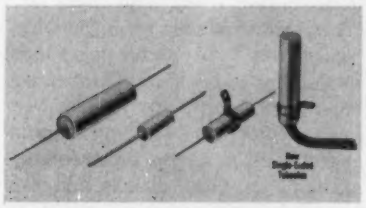
has high-level output

Model 141 Linipot miniature linear-motion potentiometer is especially suited for use in short-travel actuators, control valves, and in other accurate position-measuring applications, including test equipment and laboratory investigations. Rigid plastic body, protected by stainless-steel cover, houses the potentiometer winding and precious-metal contact assembly. Accurate high-level output sensitive to movement as small as 0.001 in. is assured by use of a ceramic mandrel wound with alloy resistance wire. Stainless-steel shaft, extending through the body, assures rigid support of internal assembly. Specifications include: 3/16 to 7/16 in. travel; linearity of ±1 per cent; resistance range from 500 to 10,000 ohms. Basic size is ¼ x 5/16 x 1¼ in., and weight is 0.2 oz. **Bourns Inc.**, 6135 Magnolia Ave., Riverside, Calif.

Circle 808 on Page 19

Single-Ended Resistor

has flexible, insulated leads



Tubeohm ceramic-jacketed wire-wound resistor has flexible, insulated leads issuing from one end of the resistor to provide complete insulation with no exposed terminals. The single-ended unit can be mounted horizontally on or under a chassis, or mounted perpendicular to or through the chassis, depending upon bracket used. Leads from taps on the resistor can also be brought out at the same end of the resistor. Units range from 5 to 25 w. **Ohmite Mfg. Co.**, 3625 Howard St., Skokie, Ill.

Circle 809 on Page 19

From the SILICONES MAN...

NEW WAYS TO KEEP HOME APPLIANCES FROM WEARING OUT THEIR WELCOME

When a new home appliance joins your family circle today, chances are that a UNION CARBIDE Silicone makes it more efficient. Silicone rubber gaskets stay flexible when icy cold, sealing your refrigerator doors tighter. Because silicones scorn heat, they're also the best seals for oven doors and pressure cooker lids. Hot cakes and fried eggs refuse to stick to silicone-resin-treated electric griddles. Silicone insulation resistant to heat and electricity is at the very heart of steam iron and electric frying pan wires and gaskets. This insulation has long served radio and TV sets, of course. But you may not know the part it plays in the motors of vacuum cleaners, fans, mixers. Here, high heat resistance lets motors run hotter, permitting smaller size and longer life, without sacrificing power. Radio transistors are made from a basic silicone chemical, as are the bonding materials that help wed glass to plastics for the linings of automatic dishwashers. The complex plastic parts of loudspeakers slip cleanly from molds, thanks to silicone release agents. And silicone-resin-base paints cover your home heating plant, which in turn is controlled by an electric clock lubricated for life with silicone oil. Yet the appliance industry is only one that has benefited from silicones. Yours can, too. To discover how, call your UNION CARBIDE Silicones Man. Silicones Division, Dept. KL-0003, Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y.

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Circle 609 on Page 19

PRODUCT APPLICATION

HANSEN SYNCHRON TIMING MOTORS

Schulmerich electro-mechanical

CARILLONIC BELL

systems . . .

Hansen SYNCHRON motors, the "heart" controlling the split-second timing of Schulmerich Carillonic Bells

SCHULMERICH CARILLONS, INC., world's largest manufacturer of electro-mechanical carillons, uses Hansen SYNCHRON Timing Motors to drive the program clock governing the all-automatic operation of these precision, perfect-tone instruments. Clock programming is offered at 15-minute intervals, 24 hours a day, 7 days a week. Scheduled to play at specified times, exactly to the minute — there is no allowance for plus or minus variation.

HANSEN SYNCHRON TIMING MOTORS were selected as an integral part of Schulmerich Carillonic Bells because they outperformed all other motors tested. Carefully controlled testing was based on four specifications: (1) instantaneous starting, (2) no time loss or gain, (3) absence of malfunction, and, (4) reliable, continuous operation for periods of a year or more. Depending on installation, motors operate at either 110 or 220 volts — 50 or 60 cycles.

SEND TODAY for informative folder containing specifications and technical data on all Hansen SYNCHRON motors and clock movements.

HANSEN MANUFACTURING COMPANY, INC.
PRINCETON, INDIANA

HANSEN REPRESENTATIVES:
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Los Angeles, Calif. — (OLive 1-3210)
Oakland, California
WINSLOW ELECTRIC CO.
New York, N.Y. — Essex, Conn. (SOuth 7-8229)
Philadelphia, Penn. Cleveland, Ohio

Sweet's Product Design File

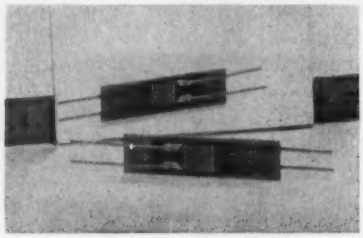
ENGINEERING DEPARTMENT

EQUIPMENT

Bending-Separator Gage

can be mounted on one side of a structure only

Flexagage bending-separator gage separates and identifies tensile strains and strains produced by bending moments on surface of a structure. Unit is composed of two strain gages, mounted on opposite sides of a piece of plastic of known thickness. It can be mounted on one side of a structure only, eliminating need for mounting strain gages back-to-back both inside and outside of structures such as pressure vessels and aircraft wings. Use of the gage



makes unnecessary difficult strain-gage mounting in inaccessible locations, hostile fluids, and areas under pressure. Maximum error without correction factors for gages used as specified is 2 per cent. Gages can be mounted with any solvent-free, room - temperature - curing, strain-gage adhesive. Gages are currently available in three models and can be used with materials 0.040 to 0.320 in. thick. **Instruments Div., Budd Co.**, P. O. Box 245, Phoenixville, Pa.

Circle 810 on Page 19

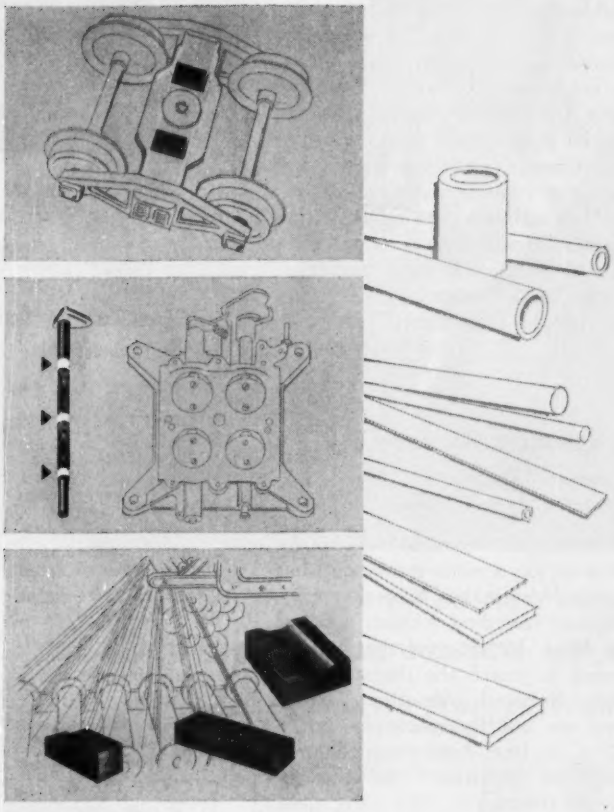
Temperature Chamber

portable unit is cooled by liquid CO_2 or dry ice

Model 1060L portable temperature chamber is heated by electric elements and cooled either by liquid CO_2 or dry ice. Sensitive meter-relay and thermocouple control temperature within $\pm 1/2$ F anywhere

NEW TEFLON BEARINGS

for Non-lubricated Service



Railroad truck bearings (top), carburetor bearings (center), and saddle bearings for textile machinery (bottom)—fabricated from top-quality Teflon* stock by Garlock—offer performance unmatched by any other material.

Now—new bearings of Teflon eliminate lubrication . . . resist extreme temperatures and reactive chemicals . . . drastically reduce downtime.

No finer combination of properties. Bearings of Teflon offer a lower coefficient of friction than any other solid material; they have exceptional thermal stability and are suitable for continuous service to +500°F; they are completely resistant to nearly all chemicals and solvents; they are tough, abrasion-resistant, have no moisture absorption.

Applied where safety and reliability are essential. Teflon is used as journal and thrust bearings, and on other sliding surfaces where lubricated bearings are undesirable, or incapable of operation in extreme temperatures or corrosive conditions, or where there is a possibility of lubricant failure. Teflon bearings afford unexcelled performance where slip-stick motion must be minimized . . . on reciprocating and oscillating systems where the lowest possible static friction must be attained . . . where space and weight savings are essential.

Easily fabricated from high-quality Garlock stock shapes. Teflon bearings can be simply and economically made from standard Garlock tape, bar and rod stock available through local Garlock distributor outlets. Or, if you wish, Garlock will work to your exact specifications in furnishing bearings of all tolerances and size. Whatever the case, the key to best bearing performance is through the use of Teflon stock shapes by Garlock. With years of experience in research and processing of plastics, Garlock is able to recommend and furnish *exactly* what you need, when you need it, and at the lowest possible cost.

Find out more about Teflon bearings. Consult your local Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada.

Or, write for Plastics Catalog AD-177, Garlock Inc., Palmyra, New York.

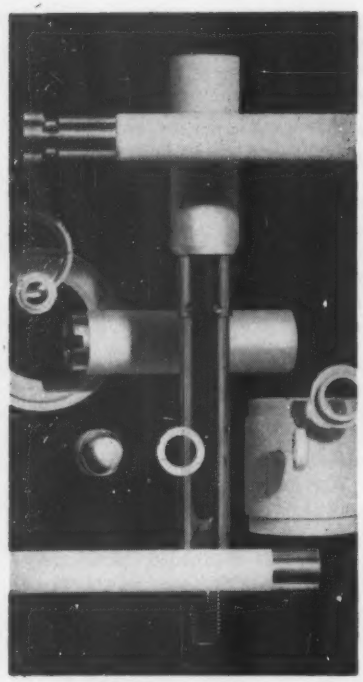
GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

*DuPont Trademark



Coors

Alumina Ceramics Replace Expensive Metals for Vital Pump Parts

The destructive twins—corrosion and abrasion—have led pump designers to use Coors High Strength Alumina Ceramics for the vital parts of pumps, such as plungers, cylinder liners, seal faces in mechanical shaft seals, shaft protection sleeves, and ball check valves.

Perhaps your abrasive and corrosive problems can be solved economically with Coors Ceramics. We shall be glad to help you—just write us at Golden or contact one of our regional sales managers.

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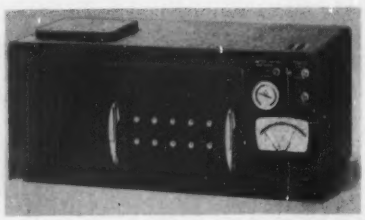
UN 4-6369—Houston, Texas

Coors
COORS PORCELAIN COMPANY
600 Ninth St. Golden, Colorado

Circle 612 on Page 19



in the range of −100 to +500 F. Overshoot or undershoot when approaching a temperature setting is eliminated by control circuitry. Centrifugal blower assures temperature uniformity throughout the test space. Test volume is 10 x 7 x 7 in., accessible through a convenient drawer containing ten sleeves for test leads. Unit operates on 117 v ac and can be programmed with an auxiliary timer to alternate between a high and a low temperature. Chamber has stainless-steel interior, aluminum exterior with gray wrinkle-enamel finish, and glass-fiber insulation. **Delta Design Inc.**, 7460 Girard Ave., La Jolla, Calif.

Circle 811 on Page 19

Temperature Recorder

operates directly from a thermocouple

Temprint miniaturized temperature recorder has a meter movement that is sensitive enough to permit temperature recording without a signal amplifier. Meter movement is calibrated to match the thermocouple. Only electrical connections necessary are the thermocouple and a 115-v, ac line. Rear-mounted knob simplifies adjustment for thermocouple resistance, eliminating need to remove turns of resistor wire. Minimum temperature span covered by the unit is 0 to 500 F, and maximum span is 0 to 2500 F. Accuracy is ±2 per cent of full scale. Standard chart speed is 1 in. per hr, al-

MUNRAY

ENGINEERED PLASTICS FOR INDUSTRY

For standards from stock or custom products designed to your needs, you can depend on Munray! . . . backed by laboratory facilities, on-site technical service, and over 15 years plastics experience!

Check these specialized tubings available from stock

AIR HOSE non-collapsing under vacuum especially resistant to abrasion, resists oils and greases, four stock sizes rated 125 psi.

CYCLON 310 crystal clear for visual inspection, resists most corrosives at temperatures from 0°—175°F, thirty-seven sizes including 6 wall thicknesses.

CYCLON 470B approved by U.S.D.A. for beverages, milk and fatty acids. 470-F formulated for other food processing applications.

CYCLON 136 designed especially to handle gasolines and similar aromatic hydrocarbons.

MUNRAY POLYETHYLENE — recommended for low pressure, low-cost applications such as instrument tubing, colored for coding, takes standard fittings.

MUNRAY NYLON accepts 1,000 and 2,000 psi operating pressures.

TEST LENGTH AVAILABLE!
STATE YOUR APPLICATION DIRECT TO

MUNRAY
PRODUCTS, DIVISION TEXTRON INC.
SPECIALISTS IN ENGINEERED PLASTICS
12406 Crosshurn Avenue Cleveland 35, Ohio
Distributors in All Major Cities

Circle 613 on Page 19

The Temperature Control Powered by the

IRREPRESSIBLE FORCE OF MERCURY—

for Accuracy with Rugged Dependability

All Partlow temperature controls are directly and positively actuated by mercury, the metal in liquid form whose reaction to changes in temperature is as predictable as it is powerful.

Unlike delicate electronic controllers, the mercury-actuated Partlow requires no outside power source. No amplifiers. No finicky levers. And no "babying"! With a Partlow you can be sure of getting accurate, dependable control even under extreme conditions of shock and vibration.

Mercury-actuation makes possible maximum design efficiency and simplicity too. The Partlow has fewer parts to go wrong. And fewer service problems (with less "down" time) should trouble occur. You can replace the thermal element of any Partlow control instantly, right at the job site, without recalibrating, fitting or factory adjustment.

Whatever the process or application, you'll find a Partlow temperature control to fit it dependably, economically, *precisely*. Mail coupon today for full details.

PARTLOW

TEMPERATURE CONTROLS

World Export:
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THE PARTLOW CORP., Dept. D-1160
NEW HARTFORD, N. Y.

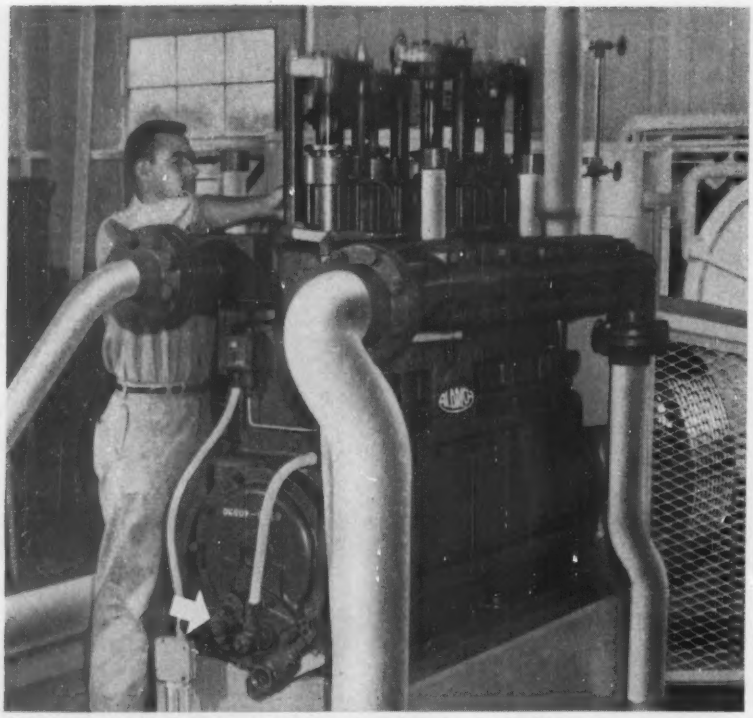
Please send condensed Catalog of Partlow temperature controls and allied equipment for industrial heating and refrigeration.

Name and Title .....

Company .....

Address .....

City and State .....

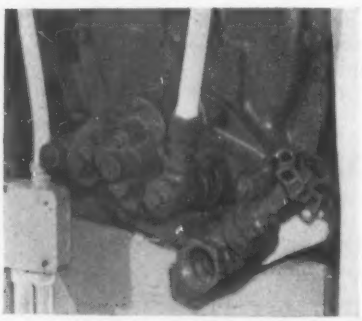


Aldrich Direct Flow Pumps are used throughout industry, for liquid transfer and in central hydraulic systems.

"Never had a 'lemon' yet in lube pumps bought from Brown & Sharpe!"

. . . Mr. S. G. Kooker, Chief Engineer, Aldrich Pump Company, Allentown, Pa.

"Nobody I know of makes a better small pump than Brown & Sharpe," says Mr. Kooker.



B&S Rotary Gear Pump (arrow, above) lubricates "power end" of Aldrich Pumps. Standard B&S Nos. 1, 2 or 4 models are used, with only slight modifications of shaft extensions or flanges.

"Their quality is tops . . . they have a full range of sizes and models to meet our requirements. And we've never had a 'lemon' yet in lube pumps bought from Brown & Sharpe!

"We've been installing them for lubrication in our reciprocating pumps for 14 years . . . and their maintenance problems have been negligible in all that time."

To help assure trouble-free performance in *your* machines, specify Brown & Sharpe pumps. They're made right, priced right! For the comprehensive Catalog No. 36P, contact Hydraulics Division, Brown & Sharpe Mfg. Co., Providence 1, Rhode Island – or your nearest B&S engineer-representative.

Brown & Sharpe

PRECISION CENTER

though other speeds are available. Chart paper is advanced by a synchronous motor drive. Recorder is 3⅝ in. wide, 5⅜ in. high, and 4⅛ in. deep. **Assembly Products Inc.**, Chesterland, Ohio.

Circle 812 on Page 19

Lettering-Guide Set

three templates have letters ½, ⅝, and ¾ in. high

No. 950 lettering-guide set consists of three lettering guides designed to facilitate equal-spaced lettering. Letters on the templates are ½, ⅝, and ¾ in. high. Scale in eighths printed on two sides of each template is of assistance to rapid spacing. Guides can be used with either pencil or fine ball-point pen. They

are 0.030-in., double-cured, mathematical-quality plastic, precision milled for smoothness of line, ease and neatness of operation, uniformity, and speed. Size of each template is 11⅜ x 3¼ in. **Rapidesign Inc.**, P. O. Box 429, Burbank, Calif.

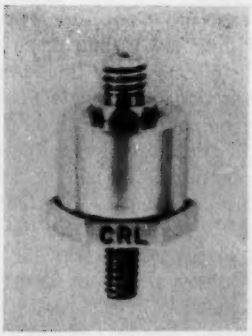
Circle 813 on Page 19

Miniature Accelerometer

has exceptionally high sensitivity

Model 502 accelerometer is a miniature pick-up that combines small size and light weight with an exceptionally high sensitivity. It is a stainless-steel, ½-in. hexagon, 0.45 in. high, weighing 9 grams. Accelerometer is suitable for low-level g studies where space and weight limitations require the use of a miniature transducer. Isolated-case design provides minimum spurious response from mounting torques, acoustic noise, and other nonvibrational environments. Frequency response ranges from 2 cps to 6 kc with resonant frequency at 100 kc. Maximum acceleration is given at 10,000 g. Temperature

Circle 615 on Page 19



range is −65 to +300 F for standard units and −65 to +500 F for high-temperature units, at less than ±10 per cent variation in sensitivity throughout both temperature ranges. **Columbia Research Laboratories,** MacDade Blvd. & Bullens Lane, Woodlyne, Pa.

Circle 814 on Page 19

Pressure Transducer

has diameter of 0.590 in.

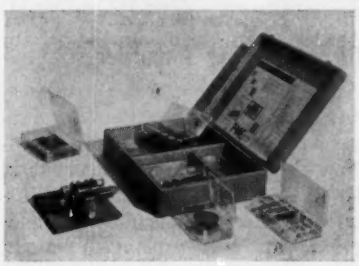
Microminiature, flush-diaphragm, absolute-pressure transducer is designed for airborne, missile, and wind-tunnel applications where small size and light weight are critical. Transducer features a flush diaphragm with high frequency response. Ranges are 0-10 to 0-100 psia, and size of the unit is 0.590 in. diam x 0.050 in. thick. **Statham Instruments Inc.,** 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 815 on Page 19

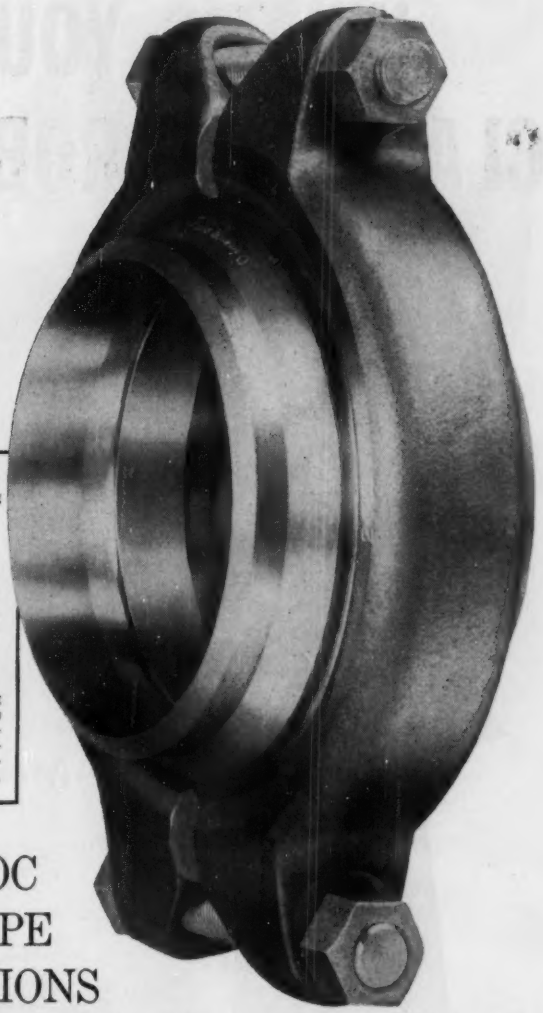
Servo Development Kit

for assembling servomechanisms with gear ratios to 78.125:1

New servo development kit, Size A, consists of a permanently packaged group of standardized servomechanism components from which a variety of mechanisms and gear trains can be assembled. Kit enables the



Taper angle of seal-ring lips is slightly less than that of mating hubs. Tightening clamp causes seal-ring lips to deflect, forming seal by spring action.



GRAYLOC PIPE CONNECTIONS HOLD PRESSURE WITHOUT LEAKING

From a full vacuum to extreme internal pressure, GRAYLOC pipe connections will not leak—will not blow out.

It's an all steel assembly with a pressure aided seal that can be quickly and easily disconnected. The seal ring is even re-usable! Yet, for all its sealing power, it's lightweight and small in size.

GRAYLOC pipe connections are manufactured in standard stock sizes from 1″ to 30″, but special sizes can be manufactured on request. They are also available made of corrosion resistant metals.

Learn how GRAYLOC pipe connections can save you time, space and money. Write for the all new GRAYLOC catalog.

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GRAY Tool Company

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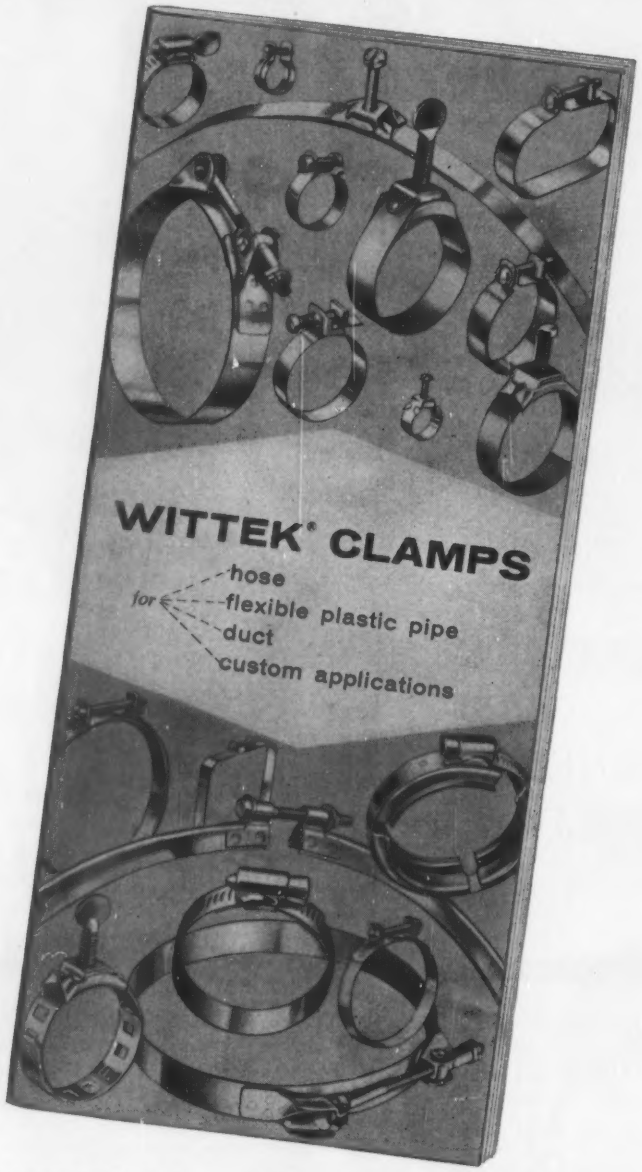
Circle 616 on Page 19

WHAT'S YOUR CLAMPING PROBLEM?



WITTEK has the answer . . .

Whatever your clamping problem, it's a safe bet that Wittek has the exact type and size clamp to do the job. Write for this new 16-page brochure on standard Wittek clamps and custom-made clamps.

Quality Clamps for Over 35 Years

WITTEK Manufacturing Co.
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CLAMPS for Every Application

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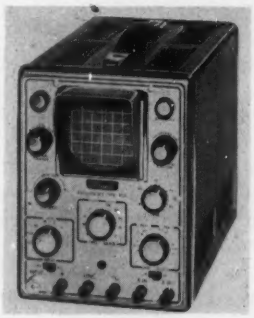
designer to prove-out a tentative design with a low-inertia mechanism closely simulating the final production unit. As many as six rotating-shaft components, including all standard miniature motors, synchros, and potentiometers, can be assembled into a complete servomechanism with gear ratios to 78.125:1. Antibacklash gears, slip clutches, and infinitely adjustable limit stops are included. Material and design requirements of MIL-E-5400C are fulfilled. Construction is anodized-aluminum alloy and corrosion-resistant steel. Ball bearings are ABEC Class 7 corrosion-resistant steel. **Precision Mechanisms Corp.**, 577 Newbridge Ave., East Meadow, N. Y.

Circle 816 on Page 19

Portable Oscilloscope

measures ac or dc voltages between 50 mv and 600 v



Graph 303C oscilloscope is a versatile, wide-band unit. Frequency-compensated attenuator calibrated in eight ranges permits accurate measurement of ac or dc voltages between 50 mv and 600 v. Rise time is 0.06 mu sec and sensitivity is 100 mv per cm. Sweep range is 1 mu sec per cm to 500 millisec per cm at minimum expansion. Unit measures 9 in. high, 6¾ in. wide, 13 in. deep, and weighs 20 lb. **Interlab Inc.**, 116 Kraft Ave., Bronxville, N. Y.

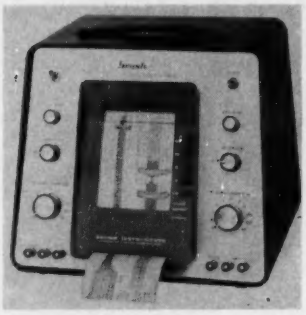
Circle 817 on Page 19

Direct-Writing Recorder

permits over 30 hr unattended operation

New electric-writing feature of Mark II direct-writing recorder permits unattended recording of analog and event data over prolonged periods

even where extremes of environmental conditions are encountered. Two channels of analog data and two channels of coded, event, or time data can be recorded instantly on a common time base by the compact recording system. Recorder has four chart speeds which can be se-



lected instantly from pushbutton controls on the recorder panel. At the slowest speed of 0.4 mm per sec, up to 31½ hr of continuous, unattended recording can be made on a standard 150-ft roll of chart paper. Pen-tip design produces high-resolution traces which are only 0.005 in. wide. Measurement range is 0.010 to 400 v. Frequency response is from dc to 100 cps. **Brush Instruments Div., Clevite Corp.**, 37th & Perkins, Cleveland 14, Ohio.

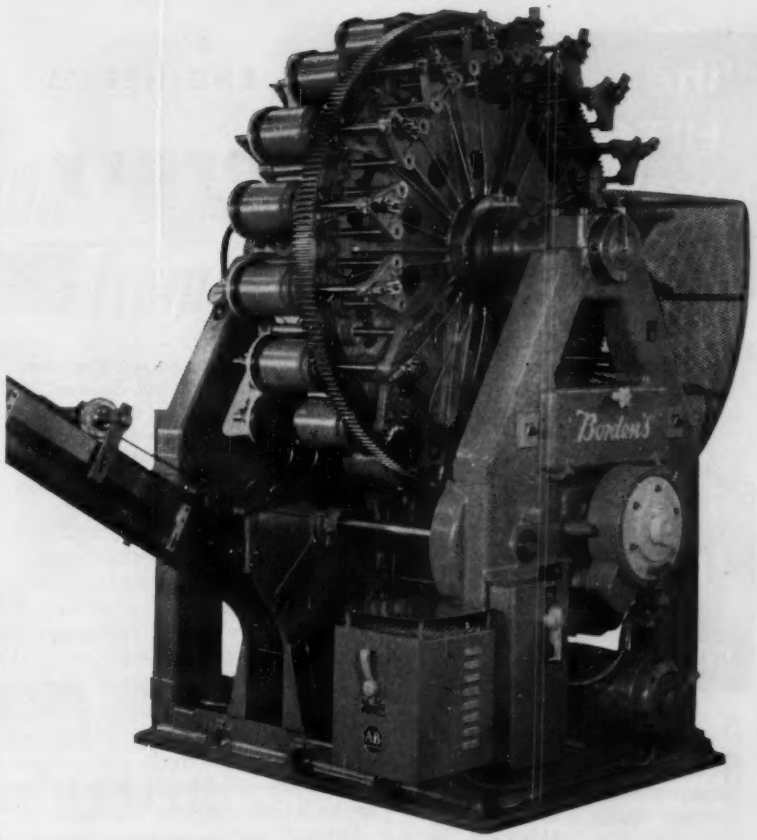
Circle 818 on Page 19

Polyester Diazo Films

for working intermediates

Black and sepia-line, polyester-base diazo films are identified Helios 517K and Helios 517, respectively. Films are suitable as working intermediates when it is desired to make revisions of an original drawing without marring the original. Original drawing is printed, in reverse, on sensitized diazo coating. Drawing is then turned over so that it is right-reading as seen through translucent 0.003-in. polyester base. Additional elements are drawn on Herculene drafting-film surface. Back-line film image has good actinic opacity and excellent visual contrast for drawing purposes. Sepia-line image is superior for reproduction purposes because of its higher actinic opacity. **Keuffel & Esser Co.**, Third & Adams Streets, Hoboken, N. J.

Circle 819 on Page 19



MAJOR SOURCE

A CASE IN POINT—The new Borden 18 pocket 4 and 5 quart Can Tester is the first pneumatic tester of this type in the world. Fast, automatic, reliable; it depends on sound, wear-resistant castings for dimensional accuracy and stability. Hamilton Foundry supplies 127 castings ranging from 2 pounds to 1300 pounds for this machine. Borden also makes a 9 pocket Tester for cans up to 2½ gallon capacity. In fact, most of the iron castings used in these machines come from Hamilton Foundry, a reliable single source for engineered castings.

When new and unusual design problems arise in selecting metal and casting parts, the skill and integrity of Hamilton Foundry is your best insurance that specifications—and delivery schedules—will be met.

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Circle 618 on Page 19

"the HITCHINER way..."

allows flexibility in design with INVESTMENT CASTING

This part is a carrier for a stripper on a citrus peeling machine. It is typical of thousands of irregularly shaped components that are designed with only a particular function in mind and no compromise with production limitations. This type of metal part often requires several changes before the design is finalized.

A late design change in this part, cast in 303 stainless steel, incorporated a 45° bevel, top and bottom on both sides of the serrated pad section. The tooling was altered at very little cost while the cost of the finished casting was not increased at all. The relatively low cost of tooling and tooling changes make the investment casting process an economical and flexible method.

Flexibility in design, a wide freedom of choice in alloy and the elimination of expensive machining operations made possible with the investment casting process may help you solve your parts problems. Send us your sample or blueprint and find out with a Hitchiner "engineered quotation" — no obligation.

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MANUFACTURING COMPANY INC.
MILFORD 15, NEW HAMPSHIRE

Coast to Coast Engineering Representatives

Circle 619 on Page 19

THE ENGINEER'S Library

Recent Books

Principles of Electricity and Magnetism. *By Emerson M. Pugh and Emerson W. Pugh: 430 pages, 6¼ by 9¼ in., clothbound; published by Addison-Wesley Publishing Co. Inc., Reading, Mass.; available from* MACHINE DESIGN, *$8.75 per copy postpaid.*

Maxwell's four field relations and the Lorentz force-on-a-charge equation are analyzed. Principles of vector algebra and calculus are treated simultaneously with elementary electrostatics.

No prior knowledge of mathematics beyond algebra and calculus is assumed. However, advanced mathematical methods are utilized when they simplify the treatment or make it more rigorous. Fundamental electrical and magnetic principles are illustrated by applications to suitable devices.

Technical Illustration. *By T. A. Thomas; 147 pages, 8½ by 11¼ in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$6.50 per copy postpaid.*

Basic procedures employed in making three-dimensional drawings are discussed. Practical techniques are emphasized.

Recent increase in use of perspective and dimetric grids, and latest line-shading techniques are covered. Several chapters are devoted to a description of special mechanical equipment and its use.

Information Processing—Proceedings of the International Conference on Information Processing, UNESCO, Paris 15-20 June 1959. *520 pages, 8½ by 12 in., clothbound; published jointly by UNESCO, Paris, R. Oldenbourg Verlag, Munich, and Butterworth Scientific Publications, London; available from Columbia University Press, Columbia University, New York 27, N. Y.; $25.00 per copy.*

Complete proceedings of the conference are presented in English and French. General subjects covered by the 61 papers are methods

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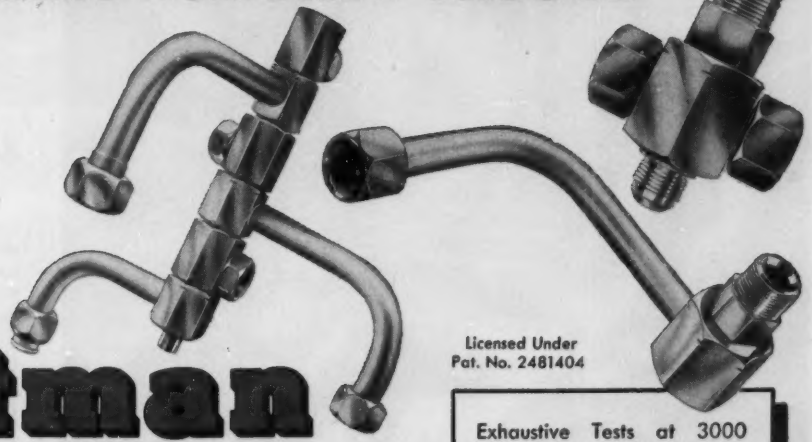
APPROACH YOUR DESIGN PROBLEMS from ANY ANGLE



with Eastman Low Cost Industrial SWIVEL CONNECTORS

Licensed Under Pat. No. 2481404

Yes, you can approach your design problems from *any angle*—from any of the six sides of EASTMAN'S *newly improved* Industrial Swivel Connector.

Never before has any fitting equaled its adaptability and versatility. You can stack them, line them up parallel, horizontal or vertical . . . in a "T," if need be.

Not only can you simplify design problems, but you can improve the maneuverability of your equipment . . . raise or lower buckets or blades. You are able to change the angle of the cut right or left, up or down . . . *on the go.*

EASTMAN Industrial Swivel Connectors eliminate costly hose failures due to excessive flexing; permit use of shorter lengths of hose and help eliminate complicated assemblies.

Improved interior design provides "balanced" fluid flow *at any angle.* Chrome hardened, cadmium plated interior surfaces, burnished to a mirror finish, improve performance. SIX sealing rings: 2 leather dust seals, 2 synthetic back-up washers and 2 quad rings of oil-resistant rubber (−40° to +200°) assure dust-free field service and less down time.

If you have been "designing around" Swivel Connectors because of high cost . . . rest assured that EASTMAN'S Industrial Swivel Connectors will not only reduce your original cost but lower your customers' operating costs as well.

Exhaustive Tests at 3000 p.s.i. through 1½ million cycles, with the connector covered with abrasives and dirt, simulating field conditions, proved EASTMAN'S Industrial Swivel Connector satisfactory in every respect and did not cause failure of any kind.

Cut corners while you cut costs with these economical Eastman Industrial Swivel Connectors.

Eliminate installations of lengthy, complicated hose assemblies, junction boxes and multiple adapters.

Improve uniform power delivery and operating efficiency, reduce costly field replacement and down time.

- **LOW TORQUE**—Freedom from friction, even under high pressure.
- **WIDE RANGE**—Operating pressures up to 3000 p.s.i. trouble-free operation through wide temperature range (−40° to +200°).
- **ROTATION**—Full 360° for all manifolds.
- **SIZES**—Steel, plated for corrosion protection—½", ¾", 1", 1¼". Other sizes available on request.

Write for Technical Bulletin No. 59 on Eastman's new improved swivel connector.

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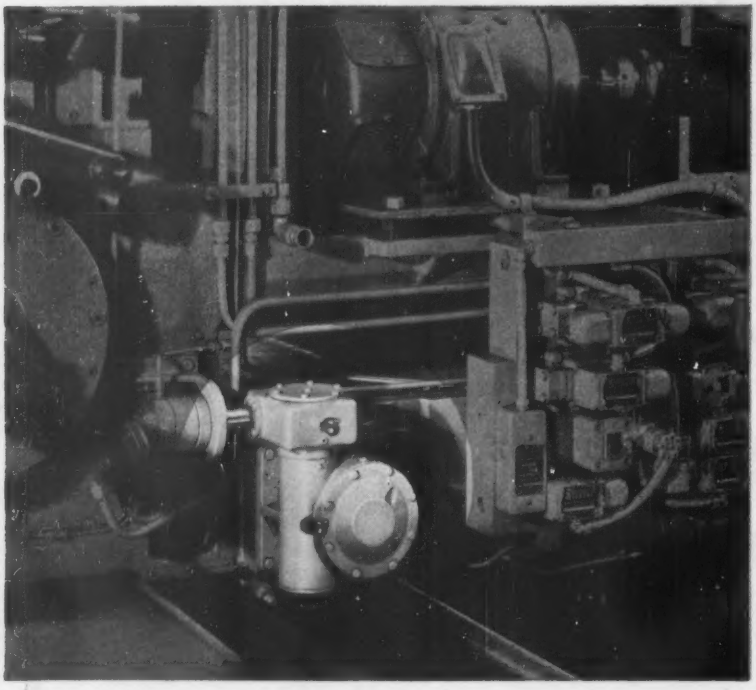
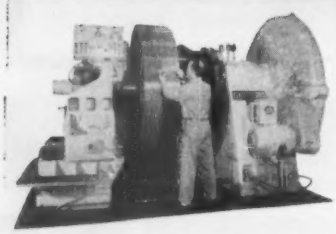
FARREL-BIRMINGHAM SELECTS WINSMITH

for compactness, heavy duty construction, ease of service





Farrel Model 10-T can cut gears having a max. pitch dia. of 120" with a 24" face. The generating feed mechanism is controlled by a hydraulic drive through a Winsmith Model 7 CVD Double Reduction Worm Gear Speed Reducer—ratio 120:1—providing maximum flexibility and a wide feed range.

Farrel Gear Generators — manufactured by Farrel-Birmingham — are machines of unusual accuracy and versatility. They are used for mass production, general jobbing and tool room work. Their speed, precision and convenience of operation increase output and decrease costs of generating gears of all types.

Farrel-Birmingham selected Winsmith Worm Gear Speed Reducers because of their compactness, precise heavy duty construction, their ease of maintenance and parts availability. These add up to maximum service — minimum maintenance and downtime.

WINSMITH SPEED REDUCERS

WRITE TODAY for complete selection information and engineering data on the hundreds of Winsmith types and sizes. For every application — from 1/100 to 85 hp., in ratios from 1.1:1 to 50,000:1 — you'll find it pays to standardize on Winsmith.

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16 Elton Street, Springville, (Erie County), N. Y.

of digital computing, common symbolic language for computers, automatic translation of language, pattern recognition and machine learning, logical design of computers, computer techniques of the future, and miscellaneous topics.

Summaries of each paper in English, French, German, and Spanish, as well as summaries in English and French of the 65 lectures given in the various specialized meetings are also included.

Association Publications

Proceedings of the National Electronics Conference—1960—Volume 16. *885 pages, 8½ by 11¼ in., clothbound; published by National Electronics Conference Inc., 228 North La Salle St., Chicago 1, Ill.; $6.00 per copy.*

More than 100 technical papers and abstracts cover such general topics as solid-state devices and circuits, digital - data transmission, feedback-control systems, antennas, magnetohydrodynamics, parametric devices and techniques, instrumentation, and logical design.

Specific topics include static analysis of radiation-powered thermoelectric generators, problems in instrumentation for dynamic subjects, plasma dynamics, development of a magnetohydrodynamic gyroscope, error recording and analysis for data transmission, and the creative engineer and management policies.

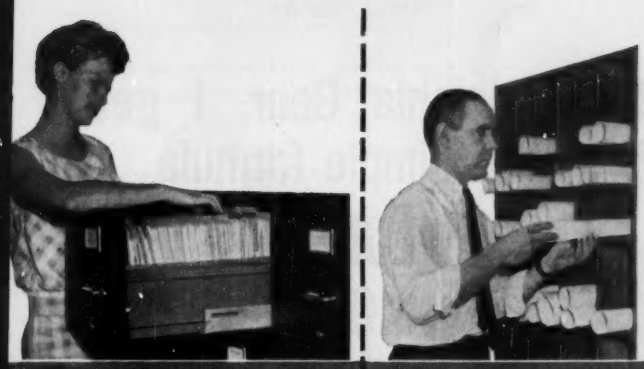
1959 References on Fatigue. *88 pages, 8½ by 11 in., paperbound, stapled; published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; $4.00 per copy.*

About 460 references to articles published in 1959 are listed. Brief abstracts of most articles have been included, and listings are arranged so that references may be cut out for filing.

Symposium on Newer Metals. *218 pages, 6 by 9 in., clothbound; published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; $7.25 per copy.*

Properties of refractory metals, nuclear and light metals, and processing of newer metals are general areas covered by the 15 papers. Specific topics include high-temperature mechanical properties of tantalum,

(What's wrong with this picture?)



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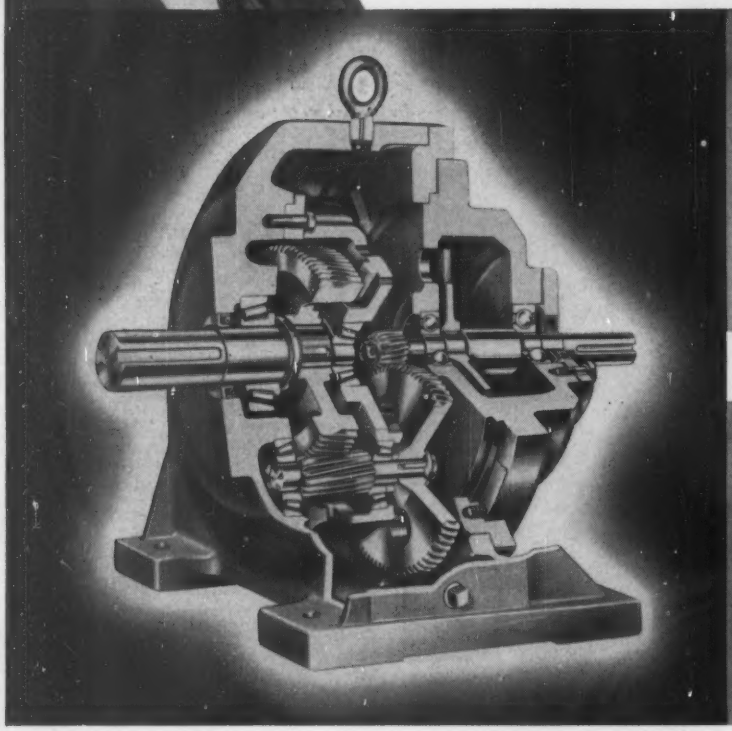
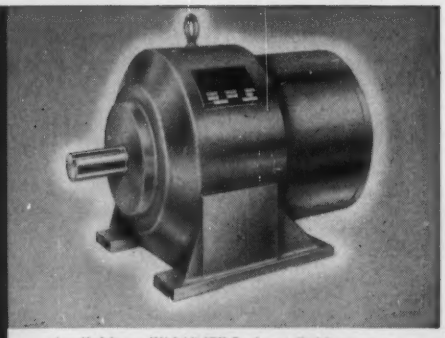
Circle 622 on Page 19

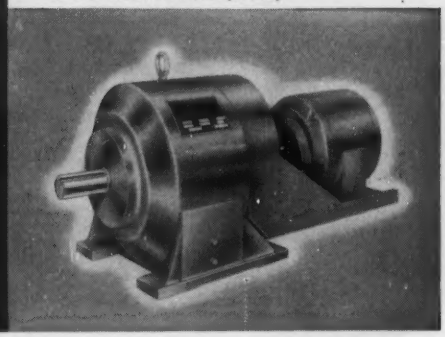
"Buying at Philadelphia Gear, I get the benefit of this simple formula..."

IMPROVED GEARS = [LONGER LIFE / MORE POWER]





Available as "IN-LINE" Reducer (left), or as a GearMotoR with flange mounted motor (above) or foot mounted motor (below).



The gearing in these drives is case hardened and precision ground, an advanced development that out-dates conventional standards and ratings. You get commercial drives with gearing of master gear quality at a cost no greater than conventional drives now in use. They are available in standard sizes to 200 H.P.

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Extreme accuracy of tooth profiles, profile spacing and surface furnish eliminates "running-in" wear.

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Harder materials, plus reduced load factors means the reducer can transmit more power, operate at higher speeds.

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Reduced load factors also mean less space and weight without sacrificing performance characteristics.

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For applications where low sound levels are important, gear noise is no longer a controlling factor.

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Send for our new Catalogs R-60 (IN-LINE Reducers) and GM-60 (GearMotoRs).

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King of Prussia (Suburban Philadelphia), Pennsylvania

tensile properties of the platinum-group metals, mechanical properties of yttrium and its alloys, and stress-rupture and creep properties of QMV beryllium metal.

Government Publications

NASA Technical Notes. Copies of publications listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-374. Effects of Various Aging Heat Treatments and Solution-Annealing and Aging Heat Treatments on Tensile, Creep, and Stress-Rupture Strengths of Inconel X Sheet to Temperatures of 1400 F. By F. W. Schmidt, John Farquhar, and Ivo M. Kurg, all from Langley Research Center; 32 pages, 7¾ by 10¼ in., paperbound, side-stapled; $1.00 per copy.

Effects of six different heat treatments were investigated. Tensile strength, minimum creep rate, 0.2 per cent creep strength in 5 and 10 hours, and 10 and 100-hr stress-rupture strength of Inconel X sheet at 1000 F, 1200 F, and 1400 F are discussed.

TN D-396. Some Experiments Concerning Subsequent Yield Surfaces in Plasticity. By Harvey G. McComb Jr., Langley Research Center; 33 pages, 8 by 10¼ in., paperbound, side-stapled; $1.00 per copy.

Combined load tests were made on seven thin-walled tube specimens of 2014-T4 aluminum alloy having a nominal outside diameter of 4.5 in., a nominal thickness of 0.156 in., and a nominal length of 24 in. Secondary yield stress was outlined in the normal-stress-shear-stress plane for an initial loading in pure tension. Significant changes in shape of stress-strain curves obtained from the tests are discussed.

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 161467. Low Temperature Tensile-Hardness Correlations of SAE 4340 Steel. 18 pages, 8 by 10½ in., paperbound, side-stapled; $0.50 per copy.

Vickers hardness and tensile strength were studied as a function of temperature on one heat of SAE 4340 steel. Martensitic, bainitic, and pearlitic structures of various strength levels were tested in the temperature range from room temperature to —196 C. Results are tabulated and discussed.

PB 161470, PB 161471. Materials Research in the Navy—Volume 1 and Volume 2: A Symposium. 764 pages, 8 by 10½ in., paperbound, Accopress binder; $6.00 and $5.00 respectively, per copy.

Research developments in metals, plastics, electronics, nuclear physics, and other fields are evaluated. Advances in engineering design and weapons development are highlighted in the 48 reports.

Some specific projects discussed are fracture toughness and crack propagation in metals, plastic foams, reinforced plastics for rocket motors, aircraft skin materials, magnetic cores and permanent magnets, and rubbers for gaskets subjected to nuclear radiation.

PB 161492. Short Time, Elevated Temperature, Stress Strain Behavior of Tensile, Compressive, and Column Members. By Eugene C. Bernett, Marquardt Corp.; 131 pages, 8 by 10¾ in., paperbound; $2.75 per copy.

Short-time tension and compression properties of four aircraft sheet materials were evaluated at room and elevated temperatures for strain rates ranging from 0.00001 to 0.1 in. per in. per sec. Short-time compression creep properties were also evaluated, and methods are presented for employing these data to define the behavior of columns at high temperatures.

PB 161690. Study of Energy Conversion Devices: Report No. 1. By R. E. Shearer, MSA Research Corp.; 29 pages, 8 by 10½ in., paperbound, side-stapled; $1.00 per copy.

A lithium hydride cell that operates regeneratively, and a potassium hydride cell that operates with a peak open-circuit voltage of 0.33 v were developed. Research work on alternate hydrides and solvents, redesign of closed systems, differential thermal analysis, and other projects are discussed.

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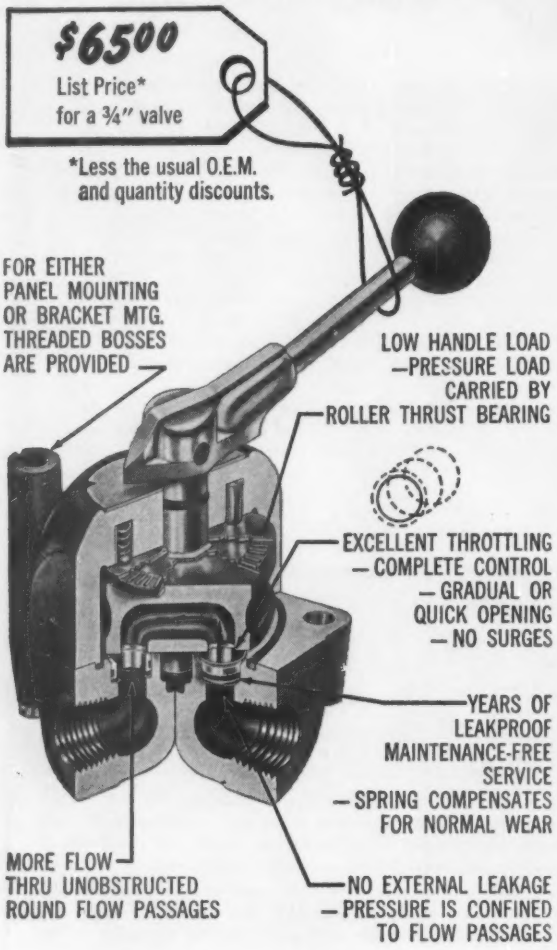

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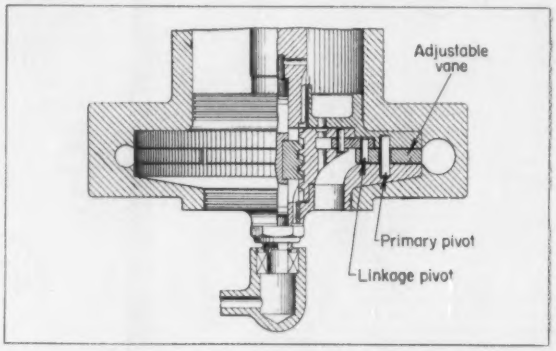
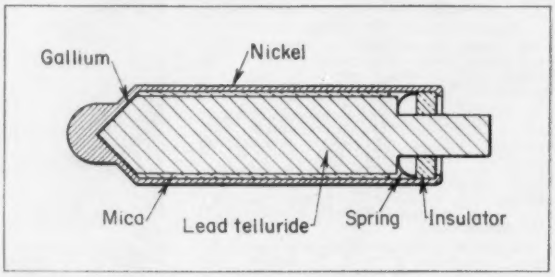


conditions. Adjustment of the vanes is made by a linkage arrangement which is controlled by a rack and gear. The position of the rack, in turn, is determined by a cylinder and fluid pressure. *Patent* 2,950,686 *assigned to Thompson Ramo Wooldridge Inc. by Alvin L. Ledel and Thomas Barish.*

Gate valve construction, in which O-rings are used as seals, is designed to establish a seal only upon the downstream side of the gate, whereby the pressure in the body space tends to be substantially the same as the inlet pressure. Fluid pressure acts to aid sealing action and to prevent dislodgment of the O-ring. *Patent* 2,950,897 *assigned to Walworth Co., New York, by Austin U. Bryant.*

Low-Resistance Contact Thermocouple



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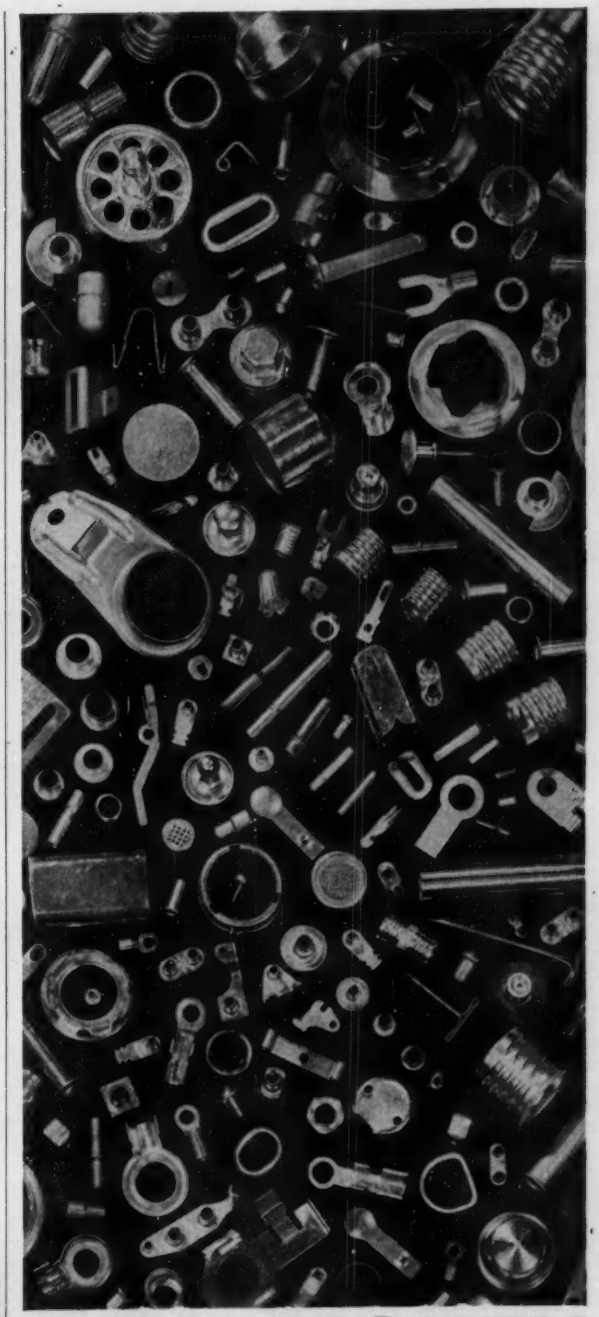

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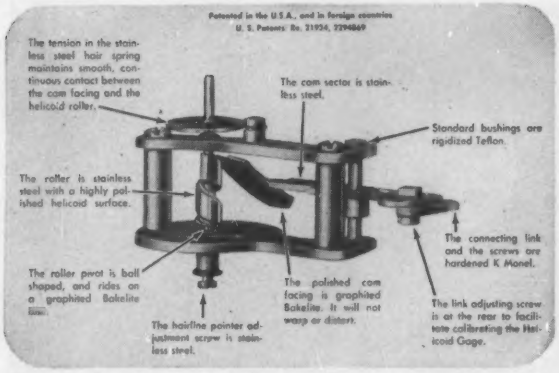
Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
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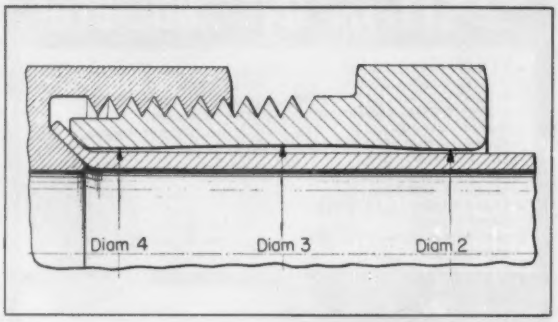
to 0.03 ohm when one of the electrodes is a semiconductor, such as lead telluride. The electrodes are held in surface contact by pressure of about 15 psi. Application temperature range is of the order of 30 to 1000 C. *Patent* 2,952,725 *assigned to Olin Mathieson Chemical Corp. by Richard C. Evans and William C. Ready.*

Fatigue-Resistant Flared-Tube Nut

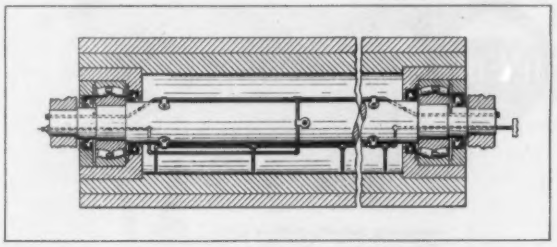
Variable bore in the nut of a flared-tube coupling accommodates flexing of the tube when subjected to vibrations, thereby minimizing fatigue cracking of the tube.



For example, bore diameters 2, 3, and 4 of 0.191, 0.194, and 0.192 in., respectively, are suited to a tube with 0.186-in. OD. *Patent* 2,952,481 *assigned to the Weatherhead Co., Cleveland, by Albert J. Weatherhead Jr.*

Lubricated Roll

Leakage of lubricating oil to the outside of a roll is prevented by use of a hollow roll and provision for leakage to the inside. Seal sizes and oil ducts are proportioned so that normal flow of excess lubricant from



the antifriction bearings is inward. The shaft is stationary and carries the ducts. Any accumulation of lubricant within the roll is siphoned off. *Patent* 2,950,150 *assigned to United States Steel Corp. by James E. Ashworth.*

Pressure-Operated Pump-Shutdown Switch

Shutdown system for steady or pulsating-flow conditions stops pump operation when fluid pressure in the discharge line falls below a predetermined minimum and is not restored within a certain time period. Cut-off device consists of a diaphragm and spring-loaded piston assembly which is mounted in the discharge line. Under normal operating conditions, the diaphragm is forced outward, moving the piston up. When pres-

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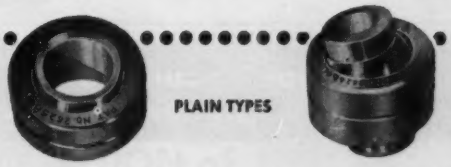

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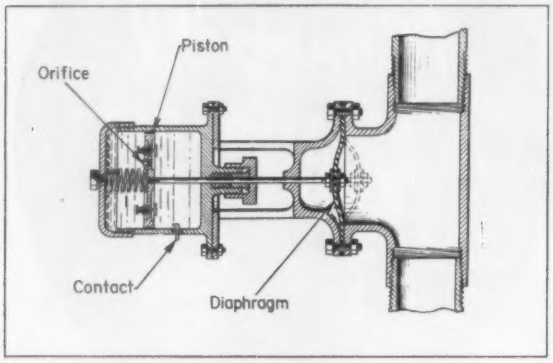
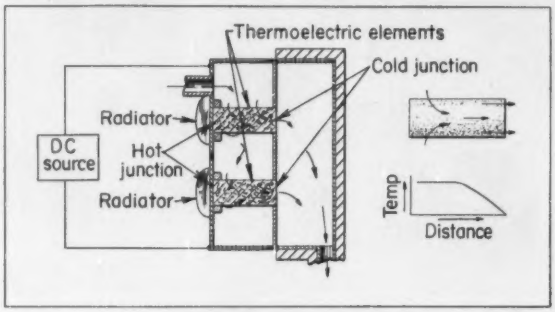
sure in the line drops below a prescribed minimum, the diaphragm flexes inward, moving the piston down. An orifice in the piston element controls the rate of piston travel to produce a time delay. When the pis-



ton reaches the bottom of its stroke, a contact is engaged, grounding the electrical system and shutting down the pumping unit. *Patent* 2,953,659 *assigned to Philips Petroleum Co., Delaware, Md., by Harold L. Edwards.*

Thermoelectric Cooler

Fluid cooling system uses semiconductor elements with thermoelectric properties to absorb heat from flowing liquids or gases. The thermoelectric circuit



consists of N and P-type semiconductors with a dc voltage source. A nonlinear temperature gradient, which limits the leakage of cold from the cold junction, is obtained by making the legs of the thermoelectric material porous. Such porosity might be produced, for example, by compacting a powdered material and sintering. This material is arranged so that the fluid being cooled passes through the material and is directed along the axis of the thermoelectric elements towards the cold junction, thus providing maximum efficiency of heat transfer. *Patent* 2,952,980 *assigned to Mire Corp., Los Angeles, Calif., by William A. Douglas.*

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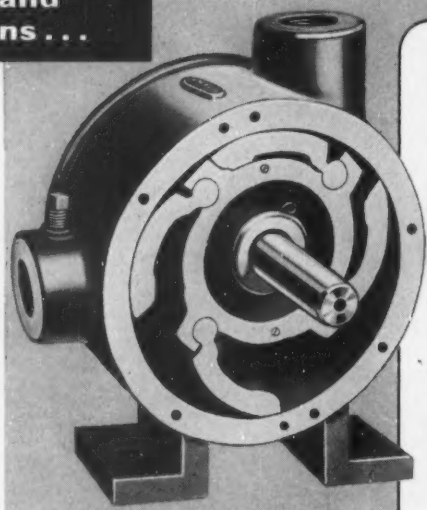

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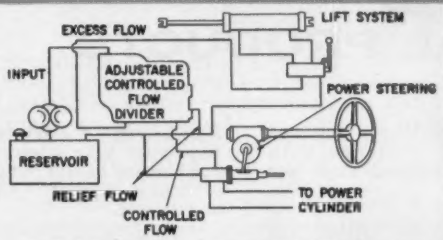

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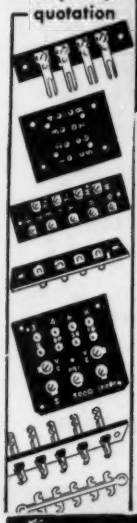

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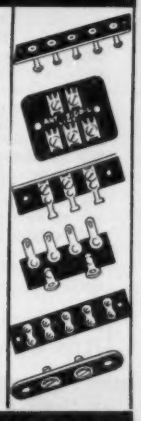

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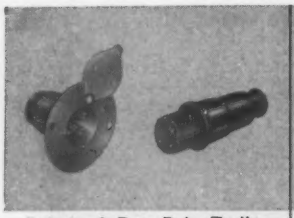

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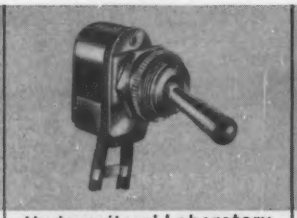

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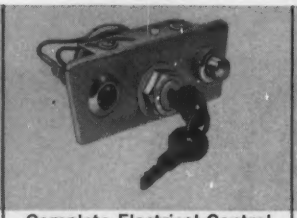

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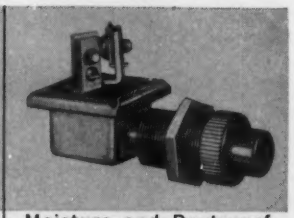

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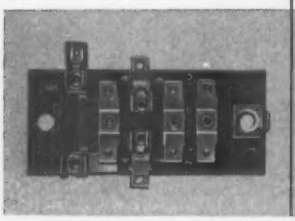
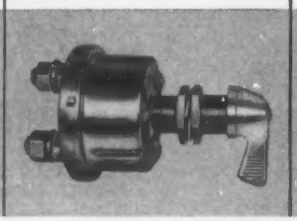
20 OLD COLONY AVENUE, BOSTON 27, MASS.

Quality ELECTRICAL PRODUCTS

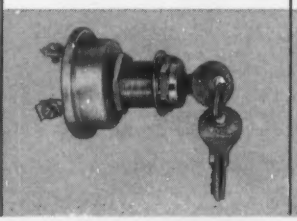
Terminal and Fuse Blocks With Fast Slip-On Type Terminals.



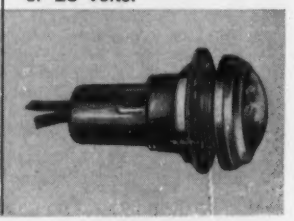
Battery Master Disconnect Switches. Single and Double-Pole Versions.



Combination Ignition Starter Switches With Coded Tumbler Lock and Keys.



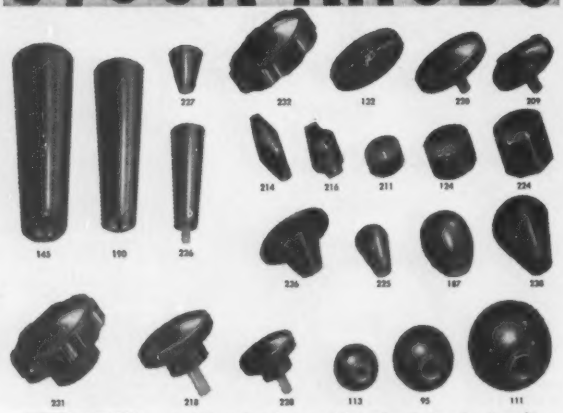
Pilot Lamps — Gasketed, Waterproof With Clear or Red Faceted Lenses. Single or Double Contact. 6, 12 or 28 volts.



Circle 638 on Page 19

STOCK KNOBS

...NO TOOLING CHARGE!



Wide selection molded plastic knobs, handles, hand-wheels at no tooling charge! Minor changes (inserts, threads, color, etc.) to suit requirements. Other modifications give your part a look of exclusive design at fraction of new mold cost! Write for complete illustrated catalog, or see Sweet's Product Design Catalog File.

DIMCO-GRAY COMPANY
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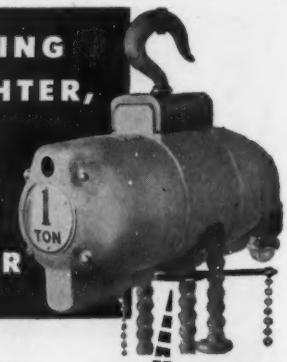
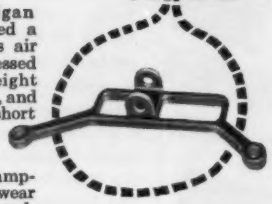
Circle 639 on Page 19

D-R STAMPING PROVES LIGHTER, STRONGER, CHEAPER, FOR HOIST MAKER



A Grand Haven, Michigan manufacturer formerly used a cast control lever on his air hoists. Converting to a pressed steel stamping saved weight without sacrificing strength, and allowed him to order in short run quantities.



Dayton Rogers' small lot stamping service saves money, wear and weight, and improves product usage. Our facilities will handle blanks 22" square; material up to 3/8" thick; and draw operations up to 4 1/4" deep.

SEND YOUR SKETCH, BLUEPRINT OR PART, PLUS QUANTITY, FOR PROMPT QUOTATION

DAYTON ROGERS
Manufacturing Company

MINNEAPOLIS 7C, MINNESOTA

Circle 640 on Page 19

Wilbow

PRECISION RUBBER PARTS SIMPLIFY SEAL DESIGN

A WILBOW Precision-Molded Shaft Seal Collar is a key factor in the remarkable performance of Bell & Gossett Booster Pumps.

This pump is the heart of the new B & G *Hydro-Flo* Heating System built into many top-quality modern homes. Its unique impeller shaft seal permits circulating oil lubrication . . . assures trouble-free, *quiet* operation. In developing this seal, Bell & Gossett engineers called on WILBOW to produce the precise molded-rubber shaft collar they needed.

WILBOW specializes in the development of molded rubber parts to meet specific design requirements and puts a full line of the newest synthetic, natural or silicone polymers at your service. Ask for our catalog to check the wide range of possibilities. Write today.

Wilbow

The WILLIAMS-BOWMAN RUBBER Co.

1951 South 54th Avenue • Cicero 50, Illinois • (Chicago Suburb)

Mfrs. of molded, punched, extruded and cut rubber goods. Specialists in producing rubber covered rolls, silicone rubber parts and bonding rubber to metal

Circle 641 on Page 19

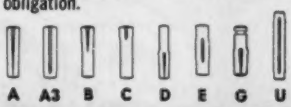
have you checked

DRIV-LOK PIN *advantages?*

1. **Positive anchoring . . . once in they *stay in* . . . yet they're reusable**
2. **Stronger, safer, solid body**
3. **Quick installation . . . Lower Costs**

DRIV-LOK Pins are effecting great economies and product improvement in applications of every type. Easy to install — just drill the hole and press or drive them in. The job is done — no reaming, no expensive hole preparation. Available in carbon steel in 8 standard types; also a wide variety of special materials. Write us, describing your fastening requirements. Catalog and samples sent without obligation.

TYPICAL APPLICATIONS:



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Circle 642 on Page 19

through, **EQUITABLE** *research:*

A NEW, DEPENDABLE SOURCE FOR CROWN GROUND PRECISION GEARS, Ssplines

EQUITABLE ENGINEERING

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CROWN GRINDING

Now you can engineer your precision gear and spline jobs to a wide range of crowned requirements—with complete assurance of having a ready, dependable, high-quality source for their production. Equitable's new C/G process is of particular benefit in the designing of missile-rocket gear boxes and precision flexible spline couplings. If you're experiencing a misalignment problem due to varying temperatures or unavoidable loading difficulties, contact Equitable's engineering staff today. We'll be happy to assist you.

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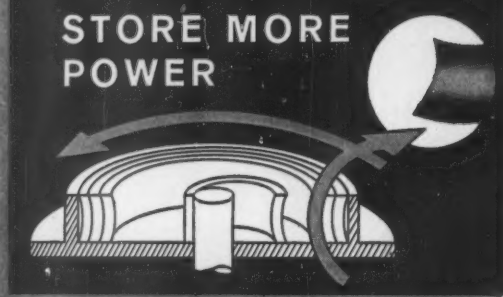
TELEPHONE LIBERTY 9-5300

Member: American Gear Manufacturers' Association

Circle 643 on Page 19

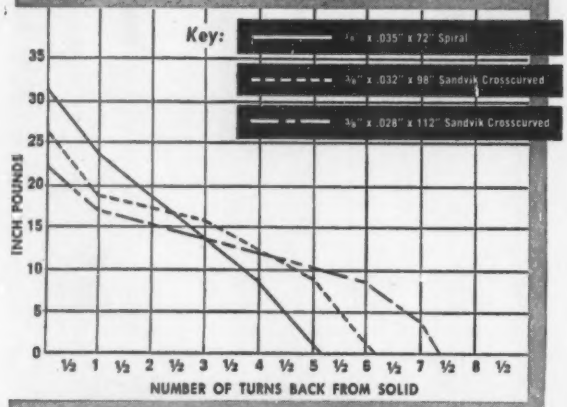
Why SANDVIK

CROSSCURVED SPRINGS STORE MORE POWER



...And Deliver It More Evenly

Sandvik crosscurved springs store energy both *along* their length and *across* their width. This dual capacity is produced by winding the spring against both its tempered spiral length and against its "*crosscurve*", a special convex curvature of the strip width.



Crosscurving is an exclusive Sandvik plus which demands superior metal. As shown in the chart, this process makes possible the use of longer, thinner springs and results in longer, steadier power delivery.

For better power output in applications such as timing instruments, carriage returns, starter rewinds, movie cameras and other high performance uses, specify Sandvik *crosscurved* springs.

Write for free data.

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Fair Lawn, New Jersey
SWarthmore 7-6200
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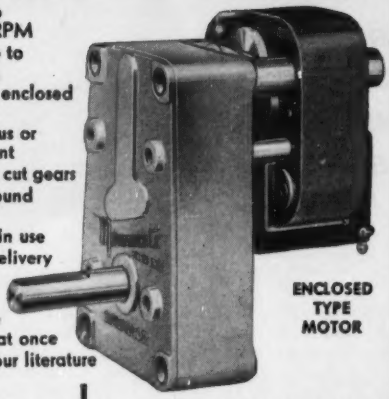
SANDVIK

Circle 644 on Page 19

GEARMOTORS

5 Basic Sizes

- Speed up to 200 RPM
- Power up to 40 in. lb.
- Open or enclosed case
- Continuous or intermittent
- Machine cut gears
- Finish ground shafts
- Millions in use
- Prompt delivery
- Special features available
- Samples at once
- Ask for our literature



ENCLOSED TYPE MOTOR

Millions of Motoresearch Gearmotors now in use!

Motoresearch also designs and produces high frequency motors, generators, rectifier type power supplies and other Special Electrical Equipment. We invite your inquiries.

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Designers and Manufacturers of
SPECIAL ELECTRICAL EQUIPMENT

Circle 645 on Page 19

A 120-AMP SHOCK FOR ENGINEERS who feel they "know brushes"!

Ohio Carbon's Electrographitic Brush Grade **D5S** rated at 80; runs at 120 amps per square inch!

Capable of a load of 120 amps per square inch, commutating well at 350°F and at 5000 fpm, with a kinetic friction coefficient of less than .4, yielding low abrasive action but creating a thin, stable commutator film free of selective action or grooving, and working well in the presence of silicone insulation (wherever not fully enclosed)...Ohio's Brush Grade D5S is but one of the outstanding D series for compact, modern, high-speed, high-h.p. motors and high-k.w. generators.

D5S load-wear graph and full information on request...from:

The OHIO CARBON COMPANY

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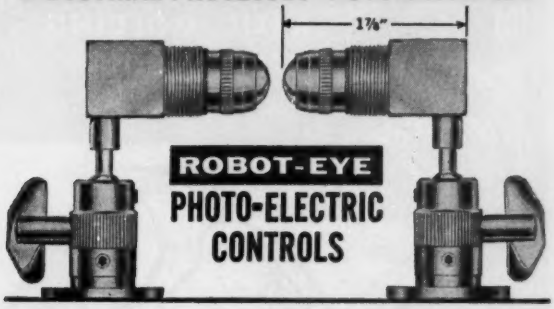
DEPT. 281
CLEVELAND 11, OHIO

Circle 646 on Page 19

count, inspect, control

INDUSTRIAL PROCESSES—AUTOMATICALLY



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Plug-in relays, receptacles for plug-in connection of lamps and cells. Additional Plug-in accessories include counters and time delays.

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Small, for "tight-spot" installation, yet rugged for long service. Accurate, for precise automatic control in virtually any industry.

INTER-CONNECTING
Plug-in terminals available for quick connection to any of a wide range of Amplifiers. This design enables you to select the most economical amplifier for your job requirements.

INEXPENSIVE
Standard Set P-5 is $17. Set P-5S is $21. Amplifiers start at $39.50. For complete data, write for Brochure MP11.

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In Canada: STANDARD INSTRUMENTS (CANADA) LTD.
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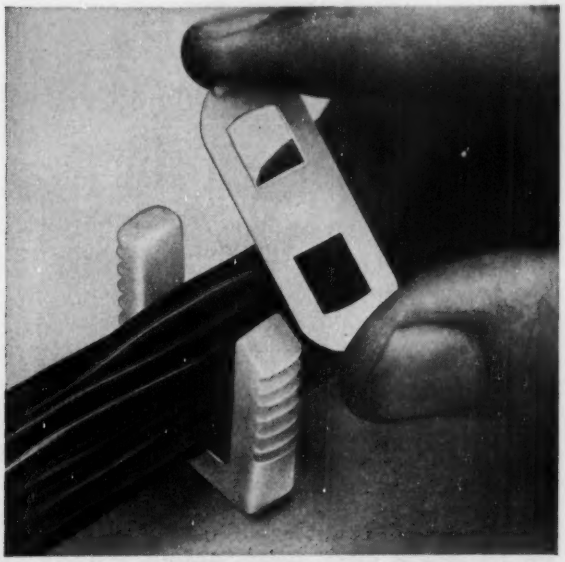
Circle 647 on Page 19



CLAMP WIRE BUNDLES IN SECONDS!

Just place wire bundle inside "U," push keeper down snugly, and this light-weight clamp is securely locked to withstand loadings greater than 50 G's! A Cab-L-Tite* clamp securing 58,000 mils weighs only 0.016 oz.; 8,570,000 mils, 0.832 oz. Proved in aircraft and missiles, Cab-L-Tite* is made of tough DuPont zytel, which meets MIL-P-17091. Removable in seconds for rerouting wires. Write for free literature. *Manufacturer of Bund-L-Tite straps.*

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4315 Sepulveda Blvd., Culver City, California

*Trade Mark

Circle 648 on Page 19

DIALCO®

OIL TIGHT

INDICATOR LIGHTS

for heavy duty industrial applications

Mounts in 1" clearance hole
No. 104-3502-XP10-231

DISCS with legends, behind flat lenses, deliver specific messages.

NO OIL, WATER, DUST or FUMES CAN PENETRATE THE *Built in* BARRIERS

(Illust. approx. 60% actual size)

Mounts in 1" clearance hole
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Mount in 11/16" clearance hole

No. 125-1308H-1191
(high brightness Neon)

Complete oil-tightness on the panel surface is assured by the use of *retained* oil-proof gaskets—plus gasketed lens assemblies in which the lens is *sealed* to its metal holder.

Designed for Severe Service: Heavy duty features include: One-piece solid brass bushing, solid brass lens holder, permanent-color glass lenses, high impact phenolic insulation, and rugged terminals.

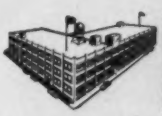
Wide Range of Sizes: Series of units are available for mounting in clearance holes ranging from 11/16" up to 1-5/8" in diameter...with several lens styles in a choice of 7 colors... with *binding screw, soldering, or quick connect* terminals.

For Neon or Incandescent Lamps (with screw-base or bayonet-base): With Neon (including *high-brightness* types) DIALCO offers BUILT-IN RESISTORS (U.S. Pat. No. 2,421,321) for use on circuits of 105-125 V., and 210-250 V.; (simple external resistors are provided for all higher voltages).

Every assembly is available complete with lamp.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Ask for Brochure L-200A.



Foremost Manufacturer of Pilot Lights
DIALIGHT CORPORATION

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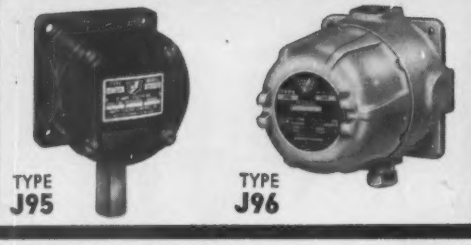
Circle 649 on Page 19

HAZARDOUS CONDITIONS? **J95 / J96**

Use UE Explosion Proof PRESSURE-VACUUM CONTROLS



TYPE J95 TYPE J96

The Types J95 and J96 Pressure-Vacuum Controls are designed for applications in hazardous locations where explosive vapors or gases are present and close on-off differential control is required. In both units, pressure settings are uncalibrated and adjustment is made by an internal nut.

Adjustable Range . . .	J95 — Various ranges between 0 and 500 psi limits. J96 — Various ranges between 0 and 180 psi limits.
Switch Differential . . .	J95 — Factory pre-set for any differential between 2 and 30 psi. J96 — Factory pre-set for any differential between 3" W.C. and 2 psi.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Maximum Pressure . .	J95 — Up to 600 psi. J96 — Up to 180 psi.
Electrical Connections .	J95 — Lead wires attached to screw type terminals on switch via ½" NPT opening. J96 — Lead wires attached to terminal block via ¾" NPT opening.
Pressure Connection . .	Via a ¼" female NPT connection.
Enclosure	J95 — Cast iron with a gray, baked-enamel finish. For use in Class I, Groups C and D locations. J96 — Cast iron base and aluminum cover. For use in Class I, Group D; Class II, Groups E, F, and G; or Class III locations.
Mounting	Surface-mounted by four corner holes with clearance for ¼" screws.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For information on modifying standard units or providing custom-built units, consult a UE application engineer. For additional data on the Types J95 and J96, request new literature available.*

UE® United Electric Controls COMPANY
91 SCHOOL STREET, WATERTOWN, MASS

Circle 650 on Page 19

Patent CUSTOM PLASTIC MOLDING SERVES YOU BETTER!

Whatever your need in plastic—utilize Patent's Custom Plastic Molding for greater economy and efficiency. Injection, compression, and plunger molding facilities offer a complete service. Call, write, or send in your inquiries today.

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PATENT BUTTON CO. of TENN. INC.

KNOXVILLE, TENNESSEE PHONE 2-9621

Circle 651 on Page 19

High heat paint problems? Use Heat-Rem H-170 up to 1700°...18 colors

Are you working out a problem with a surface that's "too hot to paint"? Heat-Rem H-170 may be the answer.

Available in 18 high heat resisting shades, it permits color coding or complete finishing of metal components subjected to temperatures from 600° to as high as 1700° (depending on color used). Typical applications are jet missile tubes, rocket motors, pressure furnaces, condensors, etc.

Heat-Rem H-170 virtually fuses with hot metal surfaces . . . forms a bright finish that's resistant to moisture, mild acids, alkalis and industrial fumes. Write for full details, requesting bulletin L-9240. A-2214A

SPECO INC. Cleveland 9, Ohio

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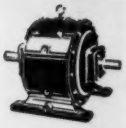
Abart SPEED REDUCERS

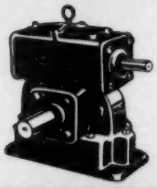
Designed and Constructed for Continuous Rugged Service

trouble-free, economical drives for any speed reduction need



Compact, precision built Abart units are available in a wide range of models from fractional to 168 hp. ratings, ratios to 10,000 to 1.

Worm, spur and combination gear models—single or double reduction—are supplied in 75 different types and sizes with any desired shaft arrangement.



Write today for Abart's hand pocket size speed reducer catalog.

ABART GEAR and MACHINE CO.

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You Get Things Done Better By Seeing What's Happening

BOARDMASTER VISUAL CONTROL

- ★ Gives Graphic Picture of Your Operations in Color.
- ★ Facts at a Glance—Saves Time and Prevents Errors.
- ★ A Simple, Flexible tool—Easily Adapted to Your Needs.
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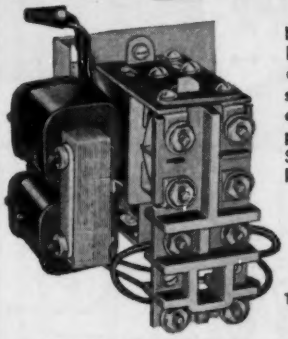
LIQUID LEVEL CONTROLS

give you all these advantages!



No moving parts in the liquid • Easy to install • No adjustments necessary • Unaffected by acids or caustics • Unaffected by pressure or temperature • Standard 2&3 pole units listed by U/L

Write for 32-page Catalog which gives complete specifications

Two pole control shown at left

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- Motor & solenoid valves
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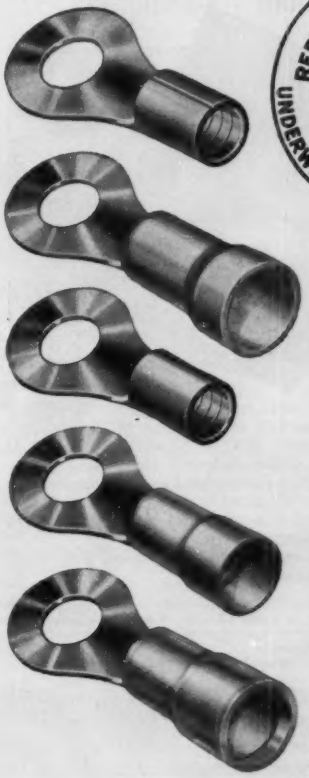

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ETC INCORPORATED
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Circle 656 on Page 19

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(metalformed, that is!)

the number to call is DIvision 2-0730

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In rockets and missiles, Spincraft has been there from the beginning. The sheath dress the lady is wearing is actually a thrust nozzle for the early Hermes missile. The trapeze dress is a section of the Honest John rocket. And the chemise is the preform stage of countless spinning jobs in missile and other fields.

Spincraft can solve your metal-forming problems quickly, efficiently, economically.

SEND FOR: *Notes for An Engineer's File.*

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SKILL WILL DO IT ®
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Circle 657 on Page 19

IDEAS! for heavy equipment designers

Looking for new solutions to heavy-duty power problems? This new brochure has full information on heavy-duty transmissions with input torque capacities of 150 to 2500 ft-lb. Included is "idea material" describing:

- Standard transmissions customized to each application
- Wide variety of "engineered-to-order" transmissions
- Specifications (capacities, speeds, gear ratios) for heavy-duty applications
- Examples of single-speed, multiple-speed and right angle drive transmissions

Send coupon for your free copy . . . or see our Catalog in *Sweet's Product Design File* today!

Cotta Transmission Co., 2340 - 11th Street, Rockford, Illinois
Please send my copy of "Cotta Heavy-Duty Transmissions" to

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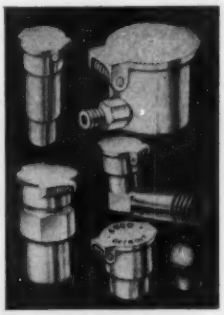
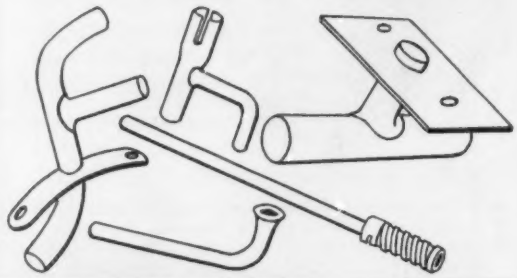


METAL TUBE FABRICATION



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Write for *NEW* OIL CATALOG No. 59 with Metal Tube Fabrication Data

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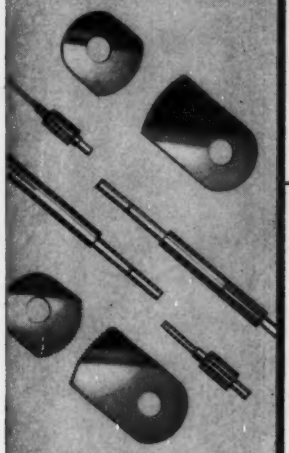
Circle 659 on Page 19

FOR INSTRUMENTS



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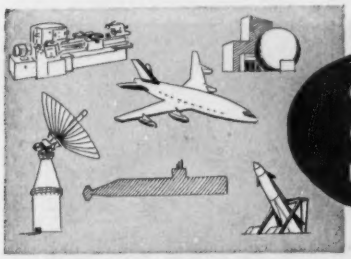

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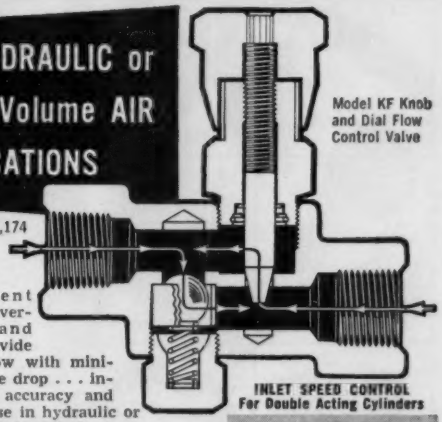
For HYDRAULIC or Large Volume AIR APPLICATIONS

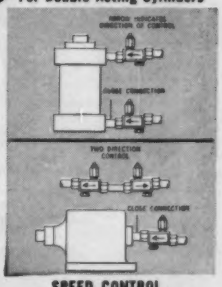


Model KF Knob and Dial Flow Control Valve

Patent #2,841,174

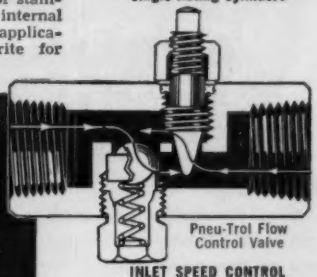
Auto-Ponent Valves with oversize ports and passages provide maximum flow with minimum pressure drop . . . insure greater accuracy and quick response in hydraulic or large volume air cylinder control. Self-aligning needle has unique Quad-Ring gland seal located at pressure port to seal off threads in needle housing, allowing needle to turn easily under maximum pressures. Gland structure and location also prevents air or dirt trapping in the housing. Flow Control and Check Valves have sensitive, chatterless ball check. Patented design insures rapid ball movement to open or close fully at low differentials. Made in 5 female Dryseal pipe sizes from ⅛" to ¾" inclusive. 3 Models: Standard, Knob and Dial, and Panel Mounting. Valve bodies are forged aluminum (3000 psi), steel or stainless steel (5000 psi). All internal parts are Stainless. Typical applications shown at right. Write for catalog AP59.

INLET SPEED CONTROL
For Double Acting Cylinders



SPEED CONTROL
Single Acting Cylinders

For AIR or LOW Volume HYDRAULIC APPLICATIONS

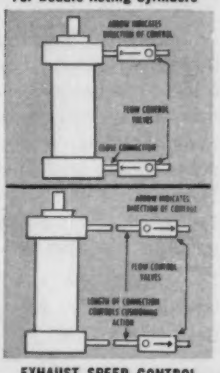


Pneu-Trol Flow Control Valve

INLET SPEED CONTROL
For Double Acting Cylinders

Patent #2,811,174

Pneu-Trol Flow Control, Needle, and Check Valves are widely used for air or small volume hydraulic cylinder control. Extremely compact design permits consolidated piping arrangements. Long tapered needle provides very sensitive and accurate air or oil flow control. Sensitive floating ball check opens or closes fully at slightest differentials. Valve bodies are machined from solid hexagon bars of aluminum or brass (2000 psi) steel and stainless steel (5000 psi). All internal parts are stainless steel. Made in 5 female Dryseal female pipe sizes: ⅛" to ¾" inclusive. Typical applications of Pneu-Trol Flow Control Valves are shown at right. Write for Pneu-Trol Valve Catalog No. 22.



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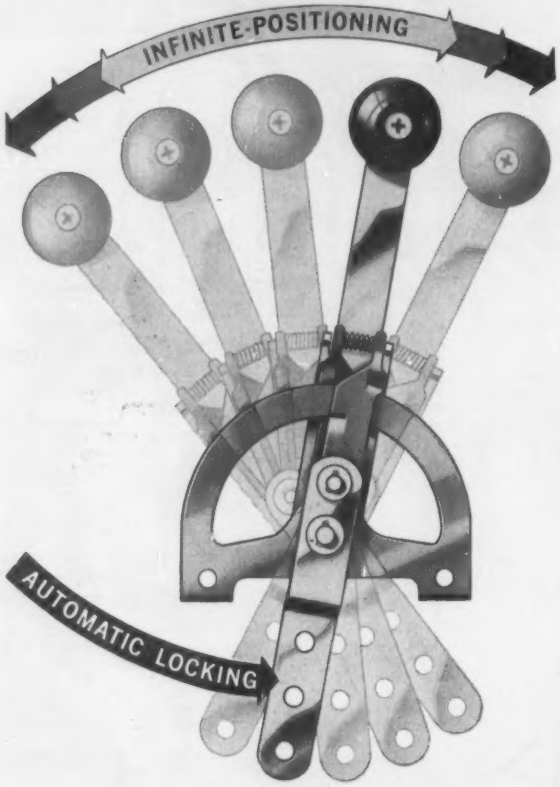
the ADAMS RITE QUADRASTAT CONTROL



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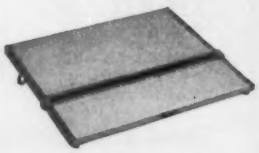

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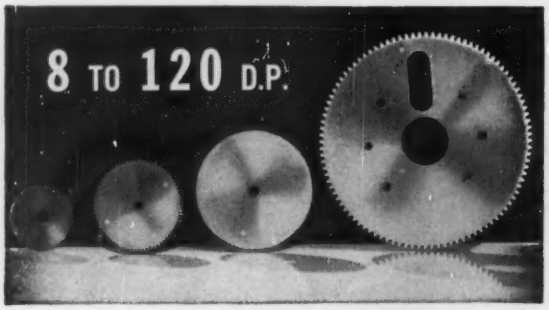

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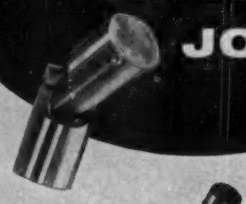

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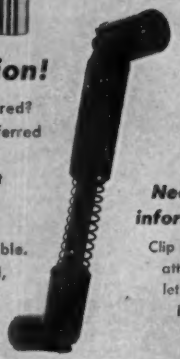

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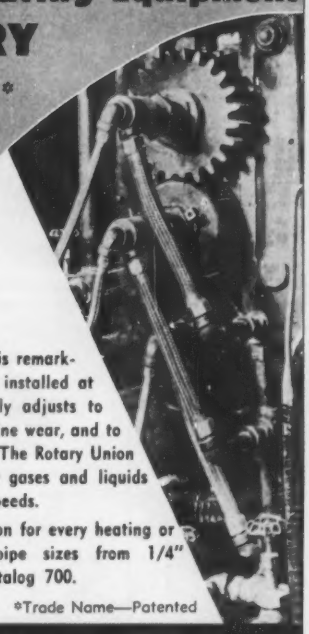

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There is a Rotary Union for every heating or cooling application—in pipe sizes from 1/4" through 5". Write for Catalog 700.

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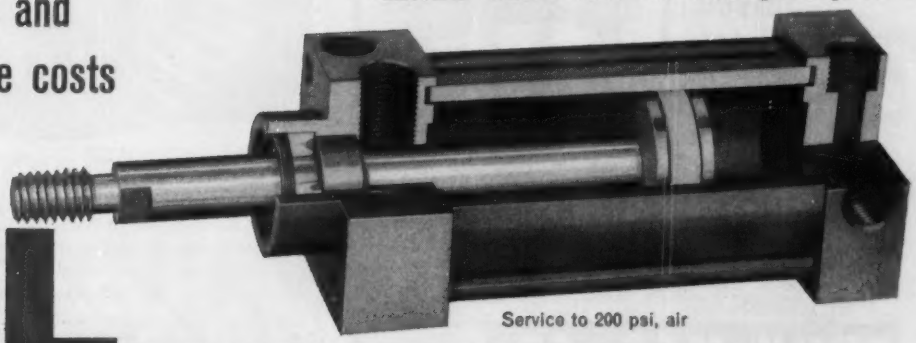

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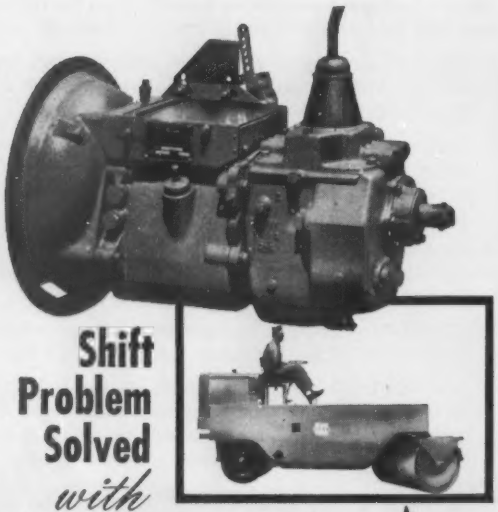
Circle 675 on Page 19



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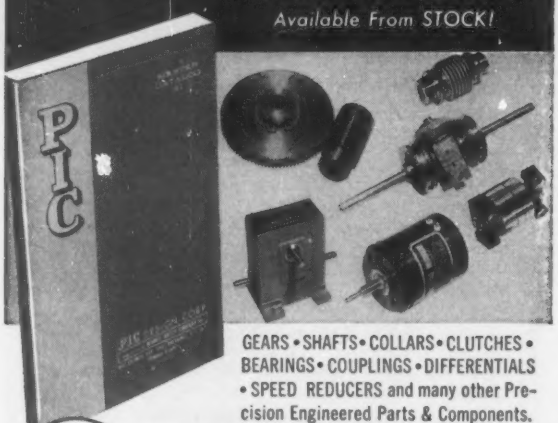

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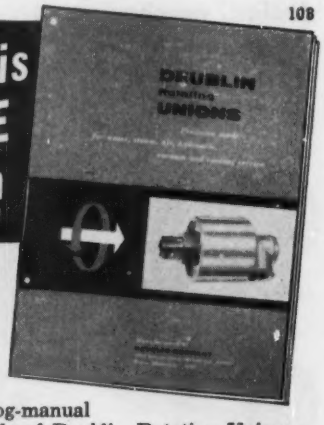

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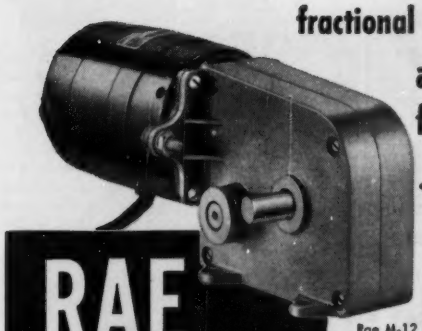

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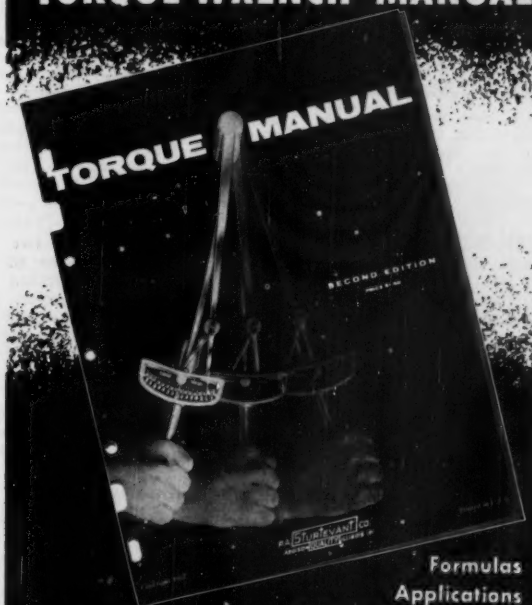
"TORQUE WRENCH" MANUAL



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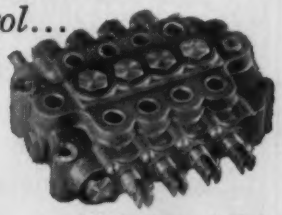
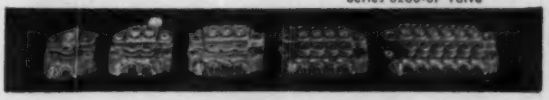
HUSCO HYDRAULIC VALVES



HUSCO 4-Plunger, 45 G.P.M. Series 3200-SP Valve



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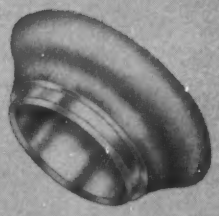

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backtalk——

—Down to the Sea

Product reliability, a primary concern of every good design engineer, assumes perhaps a greater importance when viewed through the eyes of a consumer. For example, we are crossing our fingers—and packing life jackets—after reading the contract ticket from the steamship company which is to take us on our vacation. One significant paragraph reads, in part:

> The shipowner shall not be liable for any claim whatsoever arising from Act of God, perils or accidents of the sea or other waters and of navigation; collision, stranding, jettison or wreck; fire from any cause; barratry of the master or crew or other servants of the shipowner; enemies, pirates, robbers, theft, pilferage, arrest or restraint, capture, seizure, detention; shortage or lack of fuel; explosion, bursting of boilers, steam, breakage, accidents or derangement of shafting or machinery or appurtenances; water, rain, spray, seawater, heat, smoke, frost, ice, earthquakes, floods, freshets, smell, taint, leakage, drainage from cargo, fumigation, disinfectant; unseaworthiness, latent or other defect in any part of the hull, boilers, machinery or appurtenances of the vessel . . . .

Actually, we're not at all worried about poor design of the ship—it's them perils of the sea and pirates you gotta watch out for.

—And Up the Masthead

Don Dreger, who joined our staff as an assistant editor early this year, has been promoted to associate editor. In case you've forgotten what we told you about him last February, he is a graduate of Case Institute of Technology in mechanical engineering; he was chief engineer of Ovens for Industry Inc.; and he worked for Dramaturgy Inc., engineering the moving parts of trade-show exhibits. He does printing as a hobby, and he keeps his editing arm in shape by bowling in the Penton league.

—A Leg Up from Engineers

Our Engineering News article, "Mechanisms for Amputees," which appeared in the Oct. 27 issue, said that translating research on prosthetic devices into workable hardware is largely an engineering job. That this is an area which interests all types of engineers was made clear during the recent Mechanisms Conference at Purdue University.

At this two-day meeting, nearly 200 attentive listeners heard talks by experts on kinematic design, four-bar mechanisms, six-bar linkages, cam dynamics, etc., but the subject with most audience appeal turned out to be C. W. Radcliffe's on prosthetic mechanisms. It was illustrated by Leigh Wilson, who lost his right leg in World War II and who now works with Professor Radcliffe at the University of California. Leigh first walked across the stage to see if conference attendees could tell which leg was real (they couldn't); then

he demonstrated various types of legs and their linkages, pistons, and such. In the picture (left to right) Ben Hummel, associate managing editor and co-chairman of the conference, Al Hall, Purdue co-chairman, and Professor Radcliffe, admire one of Leigh's legs.

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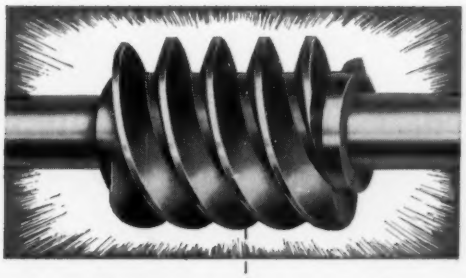

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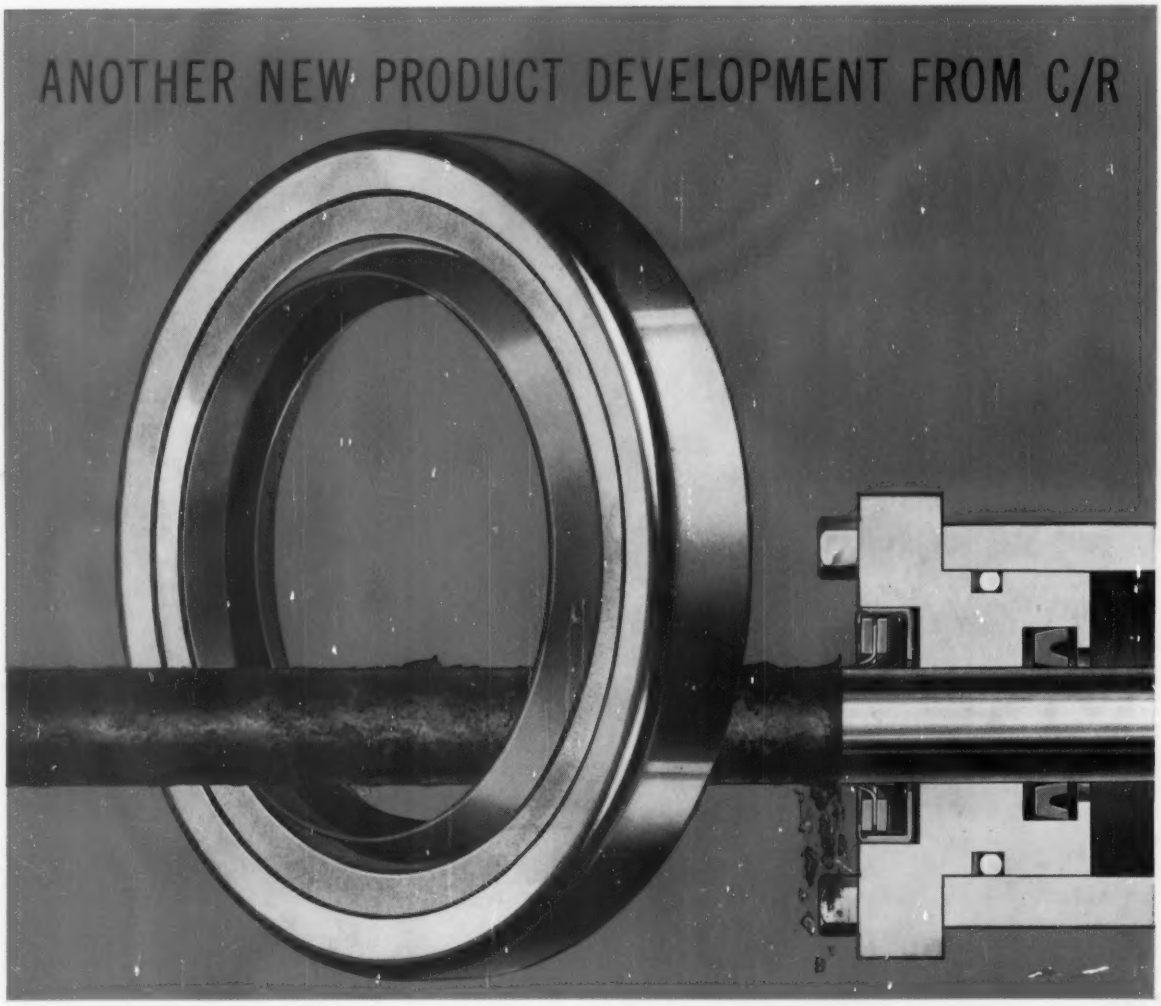

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